*XX. *Experiments for aſcertaining the Point of Mercurial Congelation. By Mr.* Thomas Hutchins, *Governor of* Albany Fort, *in* Hudſon's Bay †.

Read April 10, 1783.

THE following experiments, to determine the freezing point of quickſilver, were made by the direction of the Royal Society, at Albany Fort in Hudſon's Bay, ſituated in the latitude of 52° 14′ North and 82° Weſt longitude from Greenwich.

The inſtruments uſed in theſe experiments were ſimply thermometers, except the apparatus F and G, furniſhed by Mr. CAVENDISH, and of theſe a more ſatisfactory idea will be formed from the annexed drawing than could be conveyed by words alone; I have, therefore, only ſpecified a few particulars, ſo that each inſtrument may be diſtinguiſhed from another.

I have compared the inſtruments with each other for ſeveral weeks in the various temperatures, to adjuſt, with the greater preciſion, the relative degrees on the ſcales; which was the more neceſſary as they differed very much.

The five firſt experiments were made exactly according to the directions ſent to me by the Society, in order to obtain the point of congelation. The two ſucceeding ones are alſo made in the manner they directed, to endeavour to aſcertain the greateſt degree of contraction mercury is capable of; then follow two

† This paper having been for ſome time miſlaid, could not be printed in its turn. This accounts for the double paging and ſignatures.

experiments made in a different manner by my own ſuggeſtion; and, laſtly, an account of mercury frozen in the open air without the aid of any artificial cold, which will be found to corroborate the preceding experiments, and determine the exact point of congelation to be at 40° below the cypher. I have been careful to mark down every circumſtance attending the experiments, and have added a few obſervations to each of them, to elucidate any uncommon phænomena that occurred.

If theſe experiments ſhould be agreeable to the Royal Society, the merit muſt be attributed to the excellent inſtructions they tranſmitted to me, which left me nothing to do but to follow them; yet I cannot avoid doing juſtice to the ingenious Dr. BLACK, Profeſſor of Chemiſtry at Edinburgh, who favoured me with ſome remarks on the experiments I made in 1775 to freeze quickſilver, and firſt ſuggeſted this method of aſcertaining the point of congelation, which I had the honour of communicating to the Royal Society by the means of SAMUEL WEGG, eſq. whoſe attention to promote the views of the Society can only be equalled by that liberality of ſentiment and great goodneſs of heart which makes him encourage even the moſt feeble attempt than can in the leaſt tend to the improvement of knowledge.

THOMAS HUTCHINS.

Dr. BLACK's *Letter referred to above.*

DEAR SIR, Edinburgh, 5th Oct. 1779.

I HAVE read with great pleaſure the experiments made at Hudſon's Bay, upon the congelation of mercury, and obſerve that the author has ſucceeded perfectly in effecting it; but could not determine with preciſion what degree of cold was neceſſary to produce it. This, however, does not ſurprize me, as I have always thought it evident, from Profeſſor BRAUN's experiments, that this degree of cold cannot be diſcovered conveniently by congealing the mercury of the thermometer itſelf. I ſhall not here give my reaſons for this opinion; they would lengthen out this letter too much; I ſhall only propoſe what appears to me the proper manner of making the experiment, which is as follows: provide a few wide and ſhort tubes of thin glaſs, ſealed at one end and open at the other; the wideneſs of theſe tubes may be from half to three-quarters of an inch, and the length of them about three inches. Put an inch or an inch and an half depth of mercury into one of theſe tubes, and plunging the bulb of the thermometer into the mercury, *ſet the tube with the mercury and the thermometer in it* into a freezing mixture, which ſhould be made for this purpoſe in a common tumbler or water-glaſs; and, N. B. in making a freezing mixture with ſnow and ſpirit of nitre, the quantity of the acid ſhould never be ſo great as to diſſolve the whole of the ſnow, but only enough to reduce it to the conſiſtence of Panada. When the mercury in the wide tube is thus ſet in the freezing mixture, it (the mercury) muſt be ſtirred gently and

frequently with the bulb of the thermometer; and if the cold be ſufficiently ſtrong, it will begin to congeal by coming thick and broaſy like an amalgam. As ſoon as this is obſerved, the thermometer ſhould be examined without lifting it out of the congealing mercury; and I have no doubt, that in every experiment, thus made, with the ſame mercury, the inſtrument will always point to the ſame degree, provided it has been made and graduated with accuracy.

I am, DEAR SIR,

Your faithful humble ſervant,

JOSEPH BLACK.

To Mr. ANDREW GRAHAM, Edinburgh.

Thermometers

Thermometers deſcribed,

A. Repreſents a mercurial thermometer, with an air-bulb at the top, graduated 628 degrees below the cypher, and marked at every ſecond degree. Makers NAIRNE and BLOUNT; the ſcale box-wood.

B. Another mercurial thermometer graduated to 526° below the cypher, each line repreſenting 2°, made by NAIRNE and BLOUNT; the ſcale box-wood.

C. Is a fine mercurial thermometer, with an air-bulb at the top graduated 2300° below the cypher, each diviſion containing 5°; the ſcale made of box, by THROUGHTON.

D. A ſmall ſpirit thermometer on a box ſcale, made by THROUGHTON, and divided to every ſingle degree down to 160° below the cypher.

E. Another ſpirit thermometer, by the ſame maker (THROUGHTON) graduated 90° below the cypher; the ſcale box.

F. A ſmall mercurial thermometer, on an ivory ſcale, divided at every 5° between 220° above and 250° below the cypher; made by NAIRNE and BLOUNT.

G. Another mercurial thermometer, every way like the laſt mentioned, except only reaching from 215° above to 250° below the cypher; by NAIRNE and BLOUNT.

H. A ſpirit thermometer, made by NAIRNE and BLOUNT, with which I have made meteorological obſervations from the year 1774.

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	C.	D.	E.	F.	G	H	
1781										
Nov. 23	10 AM	+ 2½	+ 5	+ 7	+ 9	+ 8	+ 7	+ 7½		
24	10 AM	− 7	− 4	− 1	+ 2½	+ 2	0	+ 1		
	Noon	+ 2	+ 4	+ 7	+ 9	+ 8½	+ 8	+ 8½		
25	10 AM.	− 4	− 1	+ 1½	+ 4	+ 3½	+ 2	+ 2		
	3 PM.	+ 11	+ 13¾	+ 15	+ 16½	+ 15	+ 15	+ 15½		
26	10 AM.	+ 4½	+ 7	+ 8	+ 10	+ 9	+ 7½	+ 8		
27	10 AM.	0	+ 2½	+ 5½	+ 7	+ 6½	+ 5	+ 5½		
	5 PM.	+ 4½	+ 7	+ 9	+ 11	+ 10	+ 9½	+ 10		
28	10 AM	− 9½	− 6	− 2½	+ 2	+ 1½	+ 2	+ 2½		
29	10 AM.	− 3	+ ½	+ 4½	+ 6½	+ 3½	+ 3	+ 3		
30	10 PM	+ 11	+ 14	+ 15½	+ 16	+ 15½	+ 15	+ 15½		
Dec. 1	10 AM.	+ 17½	+ 20	+ 22½	+ 21½	+ 21	+ 21	+ 22		
2	11 AM.	+ 23	+ 25½	+ 27	+ 26½	+ 26	+ 27	+ 27		
3	10 AM.	+ 27½	+ 29½	+ 30½	+ 30	+ 29	+ 30	+ 30		
4	10 AM.	+ 18½	+ 20½	+ 23	+ 22	+ 21	+ 21½	+ 21		
5	10 AM.	+ 25	+ 26½	+ 27	+ 27	+ 26	+ 26½	+ 27		
6	10 AM.	+ 16	+ 18	+ 21½	+ 21	+ 20	+ 20	+ 19		
11	9 AM.	− 5	− 2½	0	+ 3	+ 2½	− 0½	0		
15	8 AM.	− 24½	− 22	− 20	− 13½	− 14	− 20	− 19½		
	Noon	− 23½	− 20½	− 18½	− 12	− 13	− 20	− 20		
16	8 AM.	− 35	− 34	− 31	− 22½	− 23	− 31½	− 31		
1782										
Jan. 7	8 AM.	− 39½	− 36½	− 35	− 25	− 25	− 31½	− 34		
11	4 PM.	− 32	− 30	− 31	− 18	− 20	− 26	− 26	− 32	
	8 PM.	− 34	− 32	− 32	− 23	− 24	− 32	− 32	− 34	
12	8 AM.	− 44	− 42	− 40	− 29	− 29½	− 40	− 39	− 42	
	Noon	− 36	− 34	− 32	− 21½	− 22½	− 33	− 32	− 37	
	4 PM.	− 28½	− 26	− 25	− 16½	− 17	− 25	− 25	− 30	
	8 PM.	− 14	− 12	− 10	− 5	− 5½	− 11	− 10	− 16	
13	8 PM.	− 19	− 18	− 15	− 8	− 9	− 15	− 15	− 20	
14	8 AM.	− 24	− 21	− 20	− 13	− 13½	− 20	− 20	− 24	
	Noon	− 22½	− 20½	− 18	− 11½	− 12	− 19	− 19	− 23	
	4 P.M.	− 24	− 22	− 20	− 13	− 14	− 21	− 21	− 25	
	8 P.M.	− 30	− 28	− 26	− 17	− 18	− 23	− 23	− 30	
15	8 AM	− 38	− 36	− 35	− 24	− 24½	− 36	− 36	− 37	
	Noon	− 32	− 30	− 27	− 18½	− 19½	− 26	− 26	− 33	
	4 P.M.	− 25	− 23	− 21	− 14	− 15	− 24	− 23	− 27	

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	C.	D.	E.	F.	G.	H.	
1782										
Jan. 16	8 AM.	− 17	− 16	− 12	− 7	− 8	− 14½	− 15	− 20	
	Noon	− 7	− 5	− 4	+ 1	− 0	− 4	− 4	− 11	
	4 PM.	− 6	− 6	− 5	− 0	− 1	− 6	− 6	− 11	
17	8 AM.	− 14	− 12	− 11	− 4	− 5	− 9	− 9	− 16	
	Noon	− 6	− 4	− 2	+ 2	+ 1½	− 3	− 3	− 10	
	4 PM.	+ 2	+ 4	+ 6	+ 8½	+ 7½	+ 5	+ 5	− 2	
	8 PM	− 4	+ 2	− 1	+ 4	+ 3	− 1	− 1	− 5	
18	8 AM.	− 9	− 8½	− 5	− 0	− 1	− 6	− 6	− 11	
	Noon	− 2	− 0	+ 2	+ 4	+ 4	− 0	− 0	− 6	
	4 PM.	− 8	− 7	− 5	− 1	− 2	− 6	− 6	− 10	
	8 PM.	− 15	− 13	− 11	− 5	− 6	− 11	− 11	− 16	
19	8 AM.	− 12	− 10	− 7½	− 4	− 4	− 9	− 9	− 14	
	Noon	− 8	− 6	− 4	− 0	− 1	− 5	− 5	− 12	
	4 PM.	− 11	− 10	− 7	− 3	− 4	− 8	− 8	− 12	
	8 PM	− 20	− 18	− 15	− 9	− 8	− 11	− 11	− 20	
20	8 AM.	− 12	− 10	− 7	− 3	− 3	− 8½	− 8½	− 13	
	Noon	− 12	− 10	− 7	− 3	− 4	− 8	− 8	− 14	
	4 PM.	− 16	− 14	− 12	− 7	− 6	− 13	− 13	− 18	
	8 PM.	− 21	− 20	− 17	− 10½	− 11	− 17	− 17	− 22	
21	8 AM.	− 38	− 36	− 33	− 24	− 25	− 38	− 38	− 37	
	Noon	− 28	− 26	− 23	− 16	− 17	− 25	− 25	− 30	
	4 PM.	− 22	− 20	− 17	− 12	− 13	− 18	− 18	− 24	
	8 PM.	− 28	− 26	− 24	− 16	− 16½	− 24	− 24	− 28	Therm. C broke this day.
22	Noon	− 19	− 17		− 8½	− 9	− 15	− 15	− 21	
	4 PM.	− 16	− 14		− 7	− 8	− 13	− 13	− 18	
	7 PM.	− 20	− 18		− 9	− 10	− 17	− 17	− 22	
23	8 AM.	− 34	− 32		− 21	− 21½	− 30	− 30	− 34	
	Noon	− 16	− 14		− 6½	− 7	− 13	− 13	− 19	
	4 PM.	− 12	− 10		− 4	− 5	− 9	− 9	− 14	
24	8 AM.	− 14	− 12		− 4½	− 5	− 10½	− 10	− 16	
	Noon	− 4	− 2		+ 3½	+ 3	− 1	− 1	− 7	
	4 PM.	+ 2	− 0		+ 5½	+ 4	+ 2½	+ 2	+ 4	
	8 PM.	− 12	− 10		− 3½	− 4	− 8	− 8	− 14	
25	8 AM.	− 30	− 28		− 18	− 18½	− 25½	− 25	− 30	
	Noon	− 30	− 28		− 17½	− 18½	− 25	− 25	− 30	

Thermometers

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	D.	E.	F.	G.	H.	
1782									
Jan. 26	8 AM.	— 103	— 80	— 33½	— 33	— 42½	— 42	— 46	Quick filver froze in air.
	9 AM.	— 323	— 444	— 29	— 29½	— 40	— 40	— 44	
	Noon	— 34	— 32	— 21	— 21½	— 30	— 29½	— 34	
	4 PM.	— 30	— 28	— 17	— 18	— 25	— 25½	— 32	
	8 PM	— 38	— 36	— 24	— 24	— 35	— 34	— 36	
27	8 AM.	— 44	— 42	— 29½	— 30	— 40	— 40	— 43	Quickfil. not frozen.
	Noon	— 28	— 26	— 16	— 17	— 24	— 24	— 28	
	4 PM.	— 26	— 24	— 14	— 14½	— 21	— 21	— 26	
	8 PM.	— 30	— 28	— 17	— 18	— 25	— 25	— 29	
28	8 AM.	— 30	— 28	— 17½	— 18	— 25	— 25	— 30	
	Noon	— 20	— 18	— 10½	— 11	— 17	— 17	— 22	
	4 PM.	— 22	— 20	— 12	— 13	— 18½	— 19	— 23	
	8 PM.	— 26	— 24	— 14	— 14½	— 22½	— 23	— 27	
29	8 AM.	— 38	— 36	— 24	— 24½	— 34	— 34	— 37	
	Noon	— 32	— 30	— 19	— 20	— 27	— 27	— 32	
	4 PM.	— 30	— 28	— 17	— 18	— 25	— 25	— 30	
30	Noon	— 24	— 22	— 13	— 14	— 21	— 21	— 26	
	4 PM.	— 26	— 24	— 14	— 15	— 20	— 20	— 26	
	8 PM	— 28	— 26	— 16	— 16	— 24	— 23½	— 28	
31	8 AM.	— 34	— 32	— 20	— 21	— 28	— 28	— 33	
	Noon	— 24	— 22	— 13	— 14	— 20	— 20	— 26	
Feb. 1	8 AM	— 38	— 36	— 24	— 24½	— 34½	— 35	— 38	
	Noon	— 28	— 26	— 16	— 17	— 25	— 25	— 9	
	4 PM.	— 22	— 20	— 12	— 13	— 19	— 19½	— 24	
2	8 AM.	— 30	— 26	— 17	— 18	— 24½	— 25	— 29	
	Noon	— 20	— 18	— 9	— 10	— 15	— 15½	— 21	
	4 PM.	— 21	— 19	— 10	— 10½	— 16	— 16½	— 22	
	8 PM.	— 22	— 20	— 10	— 10½	— 16	— 16½	— 22	
3	8 AM.	— 18	— 16	— 9	— 10	— 15	— 15	— 20	
	1 PM.	— 4	— 2	+ 4	+ 3	— 1	— 1	— 8	
	8 PM.	— 13	— 11	— 4	— 5	— 8	— 8	— 14	
4	8 AM.	— 12	— 10	— 3	— 4	— 7	— 7	— 12	
	Noon	— 8	— 6	— 0	— 0	— 4	— 4	— 10	
5	8 AM.	— 32	— 30	— 19	— 20	— 26½	— 27	— 32	
	Noon	— 16	— 14	— 6	— 7	— 13	— 13	— 18	
	4 PM.	— 12	— 10	— 3	— 4	— 7	— 7½	— 14	
	8 PM.	— 12	— 10	— 2	— 3	— 7	— 7	— 14	

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	D.	E.	F.	G.	H.	
1782									
Feb. 6	8 AM.	− 4	− 2	+ 3	+ 2	− 1	− 1	− 6	
7	8 AM.	− 34	− 32	− 20	− 21	− 28	− 28	− 32	
	4 PM.	− 14	− 12	− 5	− 6	− 10	− 10½	− 16	
	8 PM.	− 16	− 14	− 6	− 7	− 11	− 11	− 17	
8	8 AM.	− 10	− 8	− 2	− 3	− 6	− 6½	− 12	
	Noon	− 10	− 8	− 1	− 2	− 5½	− 6	− 12	
	8 PM.	− 20	− 18	− 9	− 10	− 14½	− 15	− 20	
9	7 AM.	− 24	− 22	− 14½	− 15	− 20	− 20½	− 26	
	Noon	− 22	− 20	− 11	− 12	− 17½	− 18	− 23	
	8 P.M.	− 29	− 26	− 16	− 17	− 24	− 25	− 28	
10	8 AM.	− 14	− 12	− 3½	− 4	− 9	− 9½	− 15	
	Noon	− 0	+ 2	+ 6	+ 5	+ 3	+ 2½	− 4	
	4 PM.	+ 2	+ 4	+ 7	+ 7	+ 5	+ 5	+ 2	
	8 AM.	− 2	− 0	− 6	− 5½	− 3	− 3	− 4	
11	8 AM.	− 24	− 22	− 12	− 13	− 19	− 19½	− 24	
	Noon	− 18	− 16	− 8	− 9	− 14	− 14½	− 19	
	4 PM.	− 14	− 12	− 5	− 5	− 10	− 10	− 16	
	8 PM.	− 24	− 22	− 12	− 13	− 19	− 19½	− 24	
12	8 AM.	− 2	− 0	+ 5	+ 4	+ 1	− 0	− 5	
	Noon	+ 8	+ 10	+ 14	+ 13	+ 11	+ 10½	+ 4	
	4 PM.	− 10	− 12	− 16	− 15	− 14	− 14	− 7	
	8 PM.	− 4	− 2	− 10	− 11	− 7	− 7	− 0	
13	8 AM.	− 15	− 12	− 4	− 5	− 10	− 10	− 15	
	Noon	− 12	− 10	− 1	− 2	− 5	− 5	− 13	
	4 PM.	− 6	− 4	+ 1	− 0	− 4	− 4	− 9	
	8 PM.	− 12	− 9	− 3	− 2½	− 7	− 6	− 12	
14	8 AM.	− 2	− 0	+ 6	+ 5	− 4	− 3	− 5	
	4 PM.	− 2	− 1	− 6	− 3	− 4	− 3	− 5	
15	Noon	− 10	− 8	− 1	− 2	− 5	− 5½	− 12	
	4 PM.	− 8	− 6	− 2	− 5	− 5	− 11	− 4	
16	Noon	− 0	+ 2	+ 7	+ 6	+ 4½	+ 4½	− 3	
	4 PM.	+ 4	+ 6	+ 10½	+ 9¾	+ 8	+ 8½	+ 2	
	8 PM.	+ 6	+ 4	+ 13	+ 12	+ 7	+ 7	− 4	
17	8 AM.	+ 12	− 14	− 17	− 16	− 15	− 15	− 8	
	1 PM.	− 6	− 4	− 11	− 10	− 9½	− 9	− 3	
	4 PM.	− 4	− 2	+ 4	+ 3	0	− 0	− 6	
	8 PM.	− 8	− 6	− 0	− 0	− 5	− 5	− 9	

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	D.	E.	F.	G.	H.	
1782									
Feb. 18	8 AM.	— 12	— 10	— 2	— 3	— 5½	— 6	— 12	
	Noon	— 10	— 8	— 1	— 2	— 5	— 5½	— 12	
	8 PM.	— 22	— 20	— 11	— 11	— 16½	— 17	— 22	
19	8 AM.	— 34	— 32	— 21	— 21½	— 29	— 29	— 33	
	Noon	— 18	— 16	— 7	— 8	— 13	— 13½	— 19	
	4 PM.	— 12	— 10	— 3	— 4	— 8	— 8	— 14	
	8 PM.	— 19	— 17	— 8	— 8½	— 14	— 14	— 20	
20	8 AM.	— 18	— 16	— 7½	— 8	— 13	— 13½	— 19	
	Noon	— 0	+ 2	+ 7	+ 6	+ 4	+ 3½	— 4	
	4 PM.	— 6	— 4	+ 2	+ 1	— 1	— 1½	— 7	
	8 PM.	— 8	— 6	— 0	— 1	— 4	— 4	— 10	
21	8 AM.	— 30	— 28	— 17	— 18	— 25	— 25	— 30	
	Noon	— 29	— 27	— 16½	— 17	— 24	— 24½	— 29	
	4 PM.	— 28	— 26	— 17	— 17	— 23½	— 24	— 28	
	8 PM	— 34	— 32	— 20	— 21	— 27	— 27½	— 32	
22	7 AM.	— 82	— 66	— 34	— 34	— 42	— 42	— 46	
	1 PM.	— 35	— 32	— 21	— 22	— 30	— 30	— 34	
	4 PM.	— 34	— 32	— 21	— 22	— 30	— 30	— 34	
	8 PM.	— 39	— 38	— 24½	— 25½	— 34	— 34	— 36	
23	7 AM.	— 44	— 42	— 28	— 29	— 40	— 40	— 42	
	4 PM.	— 26	— 24	— 15	— 16	— 21	— 21	— 27	
	8 PM.	— 35	— 33	— 21	— 22	— 30	— 30	— 34	
24	8 AM.	— 42	— 38	— 26	— 27	— 36	— 36	— 40	
	1 PM.	— 18	— 16	— 7	— 8	— 15	— 15	— 22	
	4 PM.	— 12	— 10	— 3	— 4	— 8	— 8	— 14	
	8 PM.	— 14	— 12	— 3½	— 4	— 10	— 10	— 15	
25	8 AM.	— 14	— 12	— 4	— 5	— 10	— 10	— 16	
	Noon	— 4	— 2	+ 3½	+ 4½	— 0	— 0	— 7	
	4 PM.	— 2	— 0	+ 5	+ 4	+ 1	+ 1	— 4	
	8 PM.	— 6	— 4	+ 3	+ 2	— 1	— 1	— 7	
26	7 AM.	— 22	— 20	— 11	— 12	— 18	— 18	— 22	
	4 PM.	— 10	— 8	— 1	— 2	— 6	— 6	— 12	
	8 PM.	— 18	— 16	— 7½	— 8	— 14	— 13	— 17	
27	8 AM.	— 24	— 22	— 13	— 14	— 20	— 20	— 25	
	Noon	— 12	— 10	— 4	— 5	— 10	— 10	— 17	
	4 PM.	— 14	— 12	— 4	— 5	— 10	— 10	— 15	
	8 PM.	— 20	— 18	— 9½	— 10½	— 15	— 15½	— 20	

Thermometers

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	D.	E.	F.	G.	H.	
1782									
Feb. 28	8 AM.	— 20	— 18	— 9	— 10	— 15	— 15½	— 22	
	Noon	— 8	— 6	+ 1	— 0	— 4	— 5	— 11	
	8 PM.	— 12	— 10	— 6	— 7	— 10	— 10	— 12	
Mar. 1	8 AM.	— 6	— 4	+ 3	+ 2	— 2	— 2	— 8	
	Noon	— 6	— 4	+ 3	— 2	— 2	— 2	— 7½	
	4 PM.	— 14	— 12	— 4	— 5	— 10	— 10	— 14	
	8 PM.	— 18	— 16	— 8	— 9	— 14	— 14	— 18	
2	9 AM.	— 20	— 23	— 13½	— 14	— 20	— 21	— 26	
	4 PM.	— 15	— 12	— 5	— 6	— 10	— 10½	— 16	
	8 PM.	— 22	— 20	— 11	— 12	— 17	— 17	— 22	
3	8 AM.	— 36	— 34	— 22	— 23	— 31	— 31½	— 35	
	1 PM.	— 12	— 10	— 2	— 3	— 7	— 7	— 16	
	4 PM.	— 10	— 8	— 2	— 3	— 6	— 6	— 12	
	8 PM.	— 18	— 16	— 7	— 8	— 13	— 13½	— 18	
4	8 AM.	— 24	— 22	— 12	— 13	— 19½	— 20	— 25	
	Noon	— 8	— 6	— 0	— 1	— 4½	— 5	— 7	
	4 PM.	— 12	— 10	— 3	— 4	— 7½	— 8	— 13	
	8 PM.	— 20	— 18	— 9	— 10	— 15	— 15	— 18	
5	8 AM.	— 32	— 30	— 19	— 20	— 26	— 26	— 30	
	Noon	— 16	— 14	— 6	— 7	— 12½	— 13	— 19	
	4 PM.	— 14	— 12	— 4	— 5	— 10	— 10	— 16	
	8 PM.	— 18	— 16	— 8	— 9	— 14	— 14	— 19	
6	8 AM.	— 19	— 17	— 8½	— 9½	— 15	— 15	— 20	
	Noon	— 10	— 8	— 1	— 2	— 6	— 6	— 13	
	4 PM.	— 12	— 10	— 2	— 3	— 7½	— 8	— 13	
	8 PM.	— 20	— 18	— 10	— 11	— 16	— 16	— 20	
7	8 AM.	— 19	— 17	— 8	— 9	— 15	— 15	— 21	
	3 PM.	— 3	— 1½	+ 5	+ 4	— 0	— 0	— 8	
	4 PM.	— 0	+ 2	+ 7	+ 6	+ 4	+ 4	— 3	
	8 PM.	— 0	+ 2	+ 7	+ 6	+ 4	+ 4	— 3	
8	Noon	+ 26	+ 28	+ 29½	+ 28½	+ 29	+ 28	+ 21	
	4 PM.	+ 16	+ 18	+ 17	+ 17	+ 17	+ 17	+ 14	
	8 PM.	— 0	+ 2	+ 7	+ 6	+ 4	+ 4	+ 4	
9	8 AM.	— 29	— 26	— 16	— 17	— 24	— 24½	— 28	
	Noon	— 14	— 12	— 4	— 5	— 10	— 10	— 16	
	4 PM.	— 11	— 9	— 2	— 3	— 6½	— 7	— 13	
	8 PM.	— 16	— 14	— 6	— 7	— 12	— 12	— 16	

Thermometers compared.

Year, Month, and Day.	Hours.	A.	B.	D.	E.	F.	G.	H.	
1782									
Mar. 10	8 AM.	−18	−16	− 7	− 6	−14	−14	−20	
	1 PM.	− 4	− 2	+ 5	+ 4	+ 1	+ 1	− 5	
	4 PM.	+ 1	+ 4	+ 8	+ 7	+ 5	+ 5	− 2	
11	4 PM.	− 0	+ 2	+ 8	+ 7	+ 4	+ 4	− 2	
	8 PM.	− 2	− 0	+ 5½	+ 6½	+ 3	+ 3	− 4	
12	8 AM.	− 2	− 0	+ 5	+ 6	+ 3	+ 3	+ 4	
	Noon	+ 2	+ 4	+12	+11	+10	+ 9½	+ 2	
	4 PM.	+ 2	+ 4	+ 9	+ 8	+ 6	+ 6	− 0	
	8 PM.	− 2	− 0	+ 5½	+ 5	+ 8	+ 7	− 6	
13	8 AM.	− 4	− 2	+ 4	+ 3½	− 0	− 0	− 6	
	Noon	− 0	+ 2	+ 7	+ 6	+ 4	+ 4	− 3	
	4 PM.	− 0	+ 2	+ 5	+ 4	+ 2½	+ 2	− 4	
	8 PM	− 7	− 5	+ 2	+ 1	− 3	− 3	−14	
14	8 AM.	−18	−15	− 7	− 8	−12½	−13	−18½	
	Noon	− 5	− 3	+ 3	+ 2	− 1	− 1	− 9	
	4 PM.	− 6	− 4	+ 2	+ 1½	− 2	− 2	− 8	
	8 PM.	−10	− 7	− 0	− 1	− 5	− 5	−10	
15	8 AM.	+ 8	+ 9	+13	+12	+11	+11	+ 2	
	Noon	+25	+26	+27	+26	+27	+26	+19	
	4 PM.	+26	+27	+28	+27	+28	+27½	+20	
	8 PM.	+26	+27½	+29	+28	+28½	+28	+20½	
16	7 AM.	+ 7	+10	+13	+12	+10½	+10	+ 6	
	4 PM.	+ 6	+ 8	+10	+10	− 7	− 7	− 4	
	8 PM.	+ 3	+ 5	+ 9	+ 8	+ 6	+ 6	− 0	
17	8 AM.	− 4	− 2	+ 4	+ 3	− 0	− 0	− 6	
	1 PM.	− 0	+ 2	+ 7	+ 6	+ 4	+ 4	− 3	
	4 PM.	− 0	+ 2	+ 6½	+ 6	+ 4	+ 4	− 3	
	8 PM.	− 2	− 0	+ 6½	+ 5½	+ 3	+ 3	− 4	
18	8 AM.	− 3	− 1	+ 5	+ 4	+ 1	+ 1	− 5	
	Noon	+ 5	+ 7	+11	+10	+10	+ 9	+ 1	
	4 PM.	+ 4	+ 6	+10½	+ 9½	+ 8	+ 8	+ 1	
	8 PM.	− 2	− 0	+ 5	+ 4	+ 2	+ 2	− 4	
19	8 AM.	− 9	− 7	− 0	− 1	− 4	− 5	−10	
	Noon	− 3	− 1	+ 4½	+ 3½	+ 1	− 0	− 6	
	4 PM.	− 4	− 2	+ 4½	+ 3½	− 1	− 0	− 6	
	8 PM.	− 6	− 4	+ 2	+ 1	− 2	− 2	−10	

Thermometers

Thermometers compared.

Year, Month, and Day.	Hour.	A.	B.	D.	E.	F.	G.	H.	
1782									
Mar. 20	8 AM.	− 4	− 2	+ 4½	+ 3½	− 0	− 0	− 6	
	4 PM.	+ 6	+ 8	+ 11½	+ 10½	+ 9	+ 8½	+ 2	
	8 PM.	+ 2	+ 4	+ 9	+ 8	+ 6	+ 6	− 0	
21	8 AM.	+ 3	+ 5	+ 10	+ 9	+ 7	+ 6	− 0	
	Noon	+ 14	+ 16	+ 18½	+ 17½	+ 17	+ 16	+ 9	
	4 PM.	+ 14	+ 16	+ 19	+ 18	+ 19	+ 18	+ 11	
	8 PM.	+ 12	+ 14	+ 17	+ 16	+ 15	+ 14½	+ 9	
22	Noon	+ 12	+ 14	+ 17	+ 16	+ 16	+ 15	+ 8	
	4 PM.	+ 14	+ 16	+ 19	+ 18	+ 18	+ 17	+ 11	
	8 PM.	+ 10	+ 12	+ 16	+ 15	+ 14	+ 14	− 8	
23	8 AM.	− 6	− 4	+ 3	+ 2	− 1	− 1	− 7	
	Noon	+ 4	+ 6	+ 11	+ 10	+ 9	+ 8½	− 0	
	8 PM.	− 0	+ 2	+ 7	+ 6	+ 4	+ 4	− 2	
24	8 AM.	− 0	+ 2	+ 8	+ 7	+ 5	+ 4	− 3	

Experiment I. made December 15, 1781.

Time *per* Watch.	Thermom. below 0.	Appara-tus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
9 22 0	25	23	—	Put them into a tumbler of ſnow.
9 31 0	—	—	—	Added the ſpirit of nitre.
9 32 0	60	40	—	Thermometer deſcends quick and equable.
9 32 20	88	40	—	
9 32 38	108	40	—	
9 32 55	120	40	—	
9 33 10	134	40	—	
9 33 29	150	40	—	
9 33 40	160	40	—	
9 34 0	176	40	—	
9 34 35	200	40	—	
9 34 57	214	40	—	
9 35 10	220	40	—	
9 35 50	252	40	—	
9 36 0	260	40	—	
9 36 29	280	40	—	
9 37 7	300	40	—	
9 37 48	320	40	—	
9 38 30	340	40	—	
9 39 6	352	40	—	
9 39 20	360	40	—	
9 39 48	370	40	—	
9 40 6	376	40	—	
9 40 38	384	40	—	
9 40 50	392	40	—	
9 41 19	400	40	—	
9 41 40	406	40	—	
9 42 10	414	40	—	
9 42 30	420	40	—	
9 43 0	426	40	—	
9 43 36	434	—	—	
9 44 0	438	40	—	
9 44 30	444	40	—	
9 45 0	448	40	—	
9 45 40	448	40	—	
9 54 0	448	40	—	

Experiment I. made December 15, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
9 55 0	448	40	—	Made a ſecond freezing mixture.
9 56 15	448	40	—	Removed the inſtruments into the ſecond mixture.
9 56 40	448	40	—	
9 57 0	448	40	—	
9 58 0	448	40	—	
9 58 40	448½	40	—	
9 59 0	448½	40	—	
10 0 0	448½	40	—	
10 0 40	448½	40	—	Added more ſpirit of nitre to the freezing mixture.
10 2 0	448½	40	—	
10 3 35	448½	40	—	Took the apparatus out of the freezing mixture, found it frozen, and immediately re-placed it.
10 4 14	448½	42	—	
10 5 0	448	42	—	
10 7 10	448	41	—	
10 9 0	448	40	—	
10 9 40	448	40	—	
10 11 0	448	40	—	Took the apparatus out again, and endeavoured to withdraw the thermometer, but could not effect it, the quickſilver in the cylinder being frozen; put the apparatus again into the mixture.
10 11 34	448	40	—	
10 12 5	448	40	—	
10 12 20	448	40	—	
10 13 28	448	40	—	
10 15 0	—	—	—	Made a third freezing mixture.
10 16 15	444	40	—	
10 16 30	442	40	—	
10 17 10	440	40	—	
10 17 26	438	40	—	
10 17 40	—	—	—	Removed the inſtruments into the third mixture.
10 18 13	446	40	—	
10 18 40	448	40	—	
10 19 0	448	40	—	
10 20 0	448	40	—	Went away to warm myſelf.
10 26 0	448	43	—	Returned.
10 27 0	448	43	—	

Experiment

Experiment I. made December 15, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
10 27 30	448	43	—	
10 28 0	448	43	14½	Put a ſpirit thermometer (D) into the freezing mixture along with apparatus and the mercurial thermometer.
10 28 30	448	43	25	
10 28 40	448	43	28	
10 28 50	448	43	30	
10 29 0	448	43	31	
10 29 40	448	43	31½	
10 30 0	447½	42½	31½	
10 30 50	447½	42½	31	Took out the ſpirit thermometer (D).
10 31 30	447½	42½	18	Put in another ſpirit thermometer (E).
10 31 50	447½	42	24	
10 32 0	447½	42	28	
10 32 20	447½	42	31	
10 32 40	447½	42	31½	
10 32 55	448	41½	32	
10 33 20	448	41½	32½	
10 33 50	448	41½	32½	
10 34 0	448	41	32½	Took out the ſpirit thermometer (E).
10 34 50	447½	40½	—	
10 35 20	447½	40½	—	Removed the Inſtruments back into the ſecond mixture.
10 35 40	440	40	—	
10 35 49	433	40	—	
10 36 0	420	40	—	
10 36 20	410	40	—	
10 36 50	400	40	—	
10 37 8	392	40	—	
10 37 20	388	40	—	
10 37 40	380	40	—	
10 38 0	372	40	—	
10 38 20	366	40	—	
10 38 33	360	40	—	
10 40 0	324	40	—	
10 42 0	270	40	—	
10 43 0	260	40	—	
10 44 0	248	40	—	

Experiment I. made December 15, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
10 44 15	244	40	—	Removed the inſtruments back to the 3d mixture.
10 44 35	246	40	—	
10 45 0	248	40	—	
10 46 0	247	40	—	
10 47 0	247	40	—	
10 48 0	246½	40	—	
10 49 0	246	40	—	
10 50 0	246	40	—	
10 51 0	245½	40	—	
10 52 0	245½	40	—	
10 53 0	244	40	—	
10 55 0	244	40	—	
10 55 20	244	40	—	Went away, to warm myſelf.
11 4 0	114	38	—	Returned.
11 9 0	54	37	—	
11 9 50	48	37	—	
11 11 0	40	36	—	
11 12 0	39	35½	—	Put in the ſpirit thermometer (D).
11 13 0	—	—	24	
11 13 40	38	35½	—	
11 14 0	38	—	26½	Took out the apparatus; the quickſilver was perfectly fluid, and the incloſed thermometer (F) was eaſily withdrawn.

Remarks and obſervations on the firſt experiment.

Finding the thermometer on Thurſday evening, the 14th of December, was 18° below the cypher, I concluded the morning would afford me an opportunity to make an attempt to fix the point at which quickſilver begins to freeze; I therefore put a bottle of ſpirit. nitri fortis upon the top of the houſe in open air, that it might be of the ſame temperature when it was to be

uſed. The thermometer had been hung up before, three weeks, in the open air, to compare their ſcales. At 7 o'clock in the morning of the 15th, the thermometers were about 23° below nought; I therefore made preparations for the experiments, getting the quickſilver out into the air, providing glaſs tumblers for mixing the nitrous acid with the ſnow, &c. I put as much quickſilver into a glaſs cylinder as (when the thermometer (F) was introduced) juſt filled the bulbous part of the cylinder; the ſcale of the thermometer did not reach the length of the tube by about three inches; and the bare part of the tube was wound round with red worſted in two places, to a thickneſs ſufficient to fill the upper part of the orifice of the cylinder in order to exclude the external air: now, as the quickſilver only filled the bulb, there was a ſpace of near half an inch left empty between the quickſilver and the neareſt piece of worſted, ſo that, by inclining the apparatus, the quickſilver readily ran out of the bulb into the other part of the cylinder. This was done with an intention to diſcover the more eaſily when the quickſilver ceaſed to be fluid; for, by taking the inſtrument out of the freezing mixture, and elevating the lower end, the quickſilver, if not frozen, would run into the void ſpace.

The experiment was made in the open air, on the top of the Fort, with only a few deer-ſkins ſewed together, placed to windward for a ſhelter: there was plenty of ſnow (eighteen inches deep) upon the works, and the thermometers were cloſe at hand. In thruſting the thermometer (F) into the quickſilver, the inſtrument roſe to the cypher, but ſoon began to deſcend again; but being unwilling to loſe time, I ſtuck the apparatus into the ſnow, the ſooner to bring it to the temperature of the air.

The

The table will fully explain the proceſs. I was in hopes, by ſhifting the inſtruments into three freſh mixtures, I ſhould have been able to have produced a greater degree of cold than by one only; yet it did not. I added more ſpirit of nitre, but without effect. At 10 h. 3′ 35″ I took out the apparatus, and raiſed the bulbous end to make the quickſilver run, but found it was frozen, ſo that it did not alter its figure in the leaſt. I then placed it in the mixture, where it contined till 10 h. 11′, when I made another trial as before, but without perceiving any alteration: however, to be more certain of its being frozen, I propoſed to take out the thermometer; but all the ſtrength in my fingers could not move it in the leaſt, ſo that myſelf and officers, who ſtood by, were convinced it was frozen faſt. I then made another mixture in hopes to augment the cold, and make the incloſed thermometer (F) deſcend; however, ſeeing no alteration, I went into the houſe to warm myſelf, and on my return found it had fallen 3°. I tried the coldneſs of the mixture by different ſpirit thermometers, and afterwards ſhifted the inſtruments into the mixture from whence I had taken them; but this diminiſhed the cold by the thermometer, ſo that I re-placed them again in the third mixture, and the quickſilver in the thermometer deſcended again to its former point 448°. I continued obſerving it ſome minutes, when the cold obliged me a ſecond time to retire, and on my return found both the thermometer and apparatus riſing: on dipping a ſpirit thermometer into the mixture, I found it had a conſiderable degree of coldneſs, and both the apparatus and mercurial thermometers were nearly equal. I then took them out, and the quickſilver in the cylinder was as fluid as when it was firſt poured in.

I ſhould have obſerved, that during the time I was pouring in the ſpirit of nitre at the beginning of the operation, I was

ſo engaged in mixing it with the ſnow, that I did not ſee the thermometer in the apparatus ſink to 40°, which muſt have been very ſudden, becauſe I was but one minute before I obſerved it. I could obſerve no alteration in the quickſilver in the cylinder when it was frozen, and intending to make more experiments, I was unwilling at this time to break the glaſs.

The time was taken by a good watch which ſhews ſeconds, and (which however I apprehend can be of little conſequence) about 5′ 10″ too faſt by apparent time. I had two aſſiſtants; one to repeat audibly every ſecond, and the other to write down the time and the obſervations as faſt as I made them.

The obſervations were taken down with a pencil, but copied fair with ink into my note book: they were compared the ſame day the experiment had been made, to avoid miſtakes; and theſe remarks were written at the ſame time, whilſt the remembrance of them was yet ſtrong on the mind.

The thermometers uſed on this occaſion were thoſe marked **A** and **F**.

Experiment II. made Dec. 16, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
8 19 30	34	31	—	Put the inſtruments into a tumbler of ſnow.
8 21 30	—	—	—	Began to pour in the ſpirit. nitri fortis.
8 21 45	40	34	—	
8 22 12	40	36	—	
8 22 40	40	36	—	
8 23 0	32	32	—	A large proportion of ſpirit of nitre poured in.
8 23 31	38	29	—	Adding ſnow to the mixture, it being too thin.
8 23 50	40	30	—	
8 24 0	43	34	—	
8 24 15	44	36	—	
8 24 40	58	40	—	
8 24 50	66	43	—	
8 25 0	76	43	—	
8 25 19	80	40	—	
8 25 29	84	40	—	
8 25 46	90	40	—	
8 26 0	94	40	—	
8 26 12	100	40	—	
8 26 24	104	40	—	
8 26 43	110	40	—	
8 27 0	116	40	—	Added more ſnow, the quantity of the mixture being ſmall.
8 27 22	126	40	—	
8 27 42	138	40	—	
8 28 0	146	40	—	
8 28 29	158	40	—	
8 28 45	164	40	—	
8 29 0	168	40	—	
8 29 25	176	40	—	
8 29 52	180	40	—	
8 30 20	184	40	—	Found the mixture did not cover the bulb of the mercurial thermometer.
8 30 50	210	40	—	Poured in more ſpirit of nitre.
8 31 20	160	40	—	
8 31 28	156	40	—	Put in ſnow by degrees, and ſtirred the mixture.
8 31 43	148	40	—	Ditto,
8 32 0	152	40	—	

Experiment II. made December 16, 1781.

Time *per* Watch.	Thermom. below 0.	Appara-tus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
8 32 10	156	40	—	
8 32 20	162	40	—	
8 32 31	168	40½	—	
8 32 48	178	42½	—	
8 33 0	188	43	—	
8 33 15	194	44	—	
8 33 26	200	44½	—	
8 33 39	206	92	—	The mercury in the apparatus thermometer ſunk ſo inſtantaneouſly, I could not catch any intermediate degrees.
8 33 47	206	95	—	
8 34 0	206	95	—	
8 34 21	206	95	—	
8 34 35	206	95	—	
8 35 0	206	95	—	
8 35 30	206	95	—	
8 36 0	206	95	—	
8 36 30	206	95	—	Put in the ſpirit thermometer D.
8 37 0	206	95	30	
8 37 30	206	95	32	
8 38 0	206	95	33	
8 38 30	206	95	33	
8 39 0	206	95	33	Made a freſh freezing mixture.
8 40 0	206	95	33	Removed all the inſtruments into it.
8 41 0	206	95	33	
8 42 0	206	95	33	
8 43 0	206	95	33	
8 44 0	206	95	33	
8 45 0	206	95	33	
8 46 0	206	95	33	
8 46 30	206	95	33	Took out the apparatus, and found the quickſilver in the cylinder frozen; replaced it.
8 46 54	206	95	33	
8 47 0	206	95	33	From 8 h. 47′ to 9 h. 11′ employed in making the next experiment.
8 48 0	206	95	33	

Experiment II. made December 16, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
9 11 0	206	95	32½	Went to breakfaſt, and, ſeeing no alteration, intended only to return now and then, it being Sunday, and prayer time being at hand.
9 50 0	206	95	31½	
10 35 0	378	Bulb	27	
10 37 10	348	D°	—	
10 38 0	320	D°	—	Took the apparatus out to examine it; then put it in again.
10 38 40	310	D°	—	
10 39 30	306	D°	—	
10 40 30	296	D°	—	
10 41 20	290	D°	27	
10 41 50	284	D°	—	
10 42 15	280	D°	27	
10 43 0	273	D°	—	
10 43 50	260	D°	—	
10 44 50	250	D°	—	
10 46 10	234	D°	—	
10 46 40	227	D°	—	
10 47 0	222	D°	26	
10 47 30	216	D°	26	
10 48 15	206	D°	—	
10 48 35	202	D°	—	
10 49 10	194	D°	—	
10 49 30	189	D°	26	
10 50 0	182	D°	—	
10 50 20	177	D°	—	
10 50 50	170	D°	26	
10 51 15	164	D°	—	Stirred the inſtruments about in the mixture.
10 51 40	156	D°	26	
10 52 20	147	D°	—	
10 52 50	141	D°	—	
10 55 5	112	D°	25¼	
10 55 30	107	D°	—	
10 56 0	102	D°	—	
10 56 15	98	D°	25	
10 56 35	94	D°	—	
10 56 50	91	D°	—	

Experiment II. made December 16, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
10 57 10	86	Bulb	—	
10 57 30	82	D°	—	
10 57 45	79	D°	25	
10 58 5	75	D°	—	
10 58 30	70	D°	—	
10 58 45	67	D°	—	
10 59 10	62	D°	—	
10 59 30	58	D°	—	
11 0 0	53	D°	—	
11 0 15	50	D°	—	
11 0 40	47	D°	24½	
11 1 0	44	D°	24½	
11 1 20	41	D°	—	
11 2 0	40	D°	—	
11 2 30	39	D°	—	
11 3 0	39	D°	—	
11 3 30	39	D°	—	
11 4 0	38½	D°	—	The mercury in the apparatus thermometer raiſing up the tube from the bulb.
11 4 20	38	235	—	
11 4 30	38	225	—	
11 4 40	38	220	—	
11 4 50	38	218	—	
11 5 0	38	205	—	
11 5 10	38	195	—	
11 5 20	38	183	—	
11 5 33	38	172	—	
11 5 44	38	163	—	
11 5 55	38	154	—	
11 6 10	38	140	—	
11 6 20	38	130	—	
11 6 30	37	120	—	
11 6 40	37	110	—	
11 6 50	37	97	—	
11 7 0	37	87	—	
11 7 10	37	78	—	
11 7 20	37	67	—	

Experiment II. made December 16, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
11 7 40	37	47	—	
11 8 0	37	38	—	
11 8 20	37	38	—	
11 8 40	37	38	23½	
11 9 15	37	37½	—	
11 9 30	37	37	—	Examined apparatus, quickſilver in the cylinder perfectly fluid.
11 15 0	36	35	23	

This experiment was made with the ſame inſtruments as the preceding, and the quickſilver which was left yeſterday in the cylinder was the ſame now employed. I was rather unfortunate in making too ſmall a quantity of the freezing mixture at the beginning, which obliged me to make repeated additions to it: by this means the operation was not only retarded, but ſometimes it even undid what had been done; for in pouring in the nitrous acid it was unavoidable but part of it ſhould come in contact with the bulbs of the inſtruments before it was mixed with ſnow. In this caſe it never failed making the thermometers riſe ſuddenly much higher than where they ſtood before the ſpirit was added; and at length it only deſcended to 206°, which is not half ſo low as on the preceding day, though the temperature of the air was ten degrees colder (*viz.* 34°): yet it is remarkable, that though the thermometer was ſo much higher, the apparatus was ſunk more than twice as low as the day before; for after having been long ſtationary at 40°, it ſunk

to 95°. I then made a freſh mixture, but it had no effect any way during three quarters of an hour I attended to it afterwards. During this idle interval I made the third experiment. Finding no alteration, I went down to breakfaſt, and on my return was ſurpriſed to find the quickſilver in the apparatus thermometer had ſubſided into the bulb, and the ſtandard thermometer had been very low (how low I cannot tell), and was riſing briſkly. The ſpirit thermometer alſo ſhewed the mixture had a leſs degree of cold than before. To be certain that the quickſilver in the apparatus thermometer was in the bulb, I took the apparatus out of the mixture, and examined it minutely for half a minute, till I was quite certain of it; and alſo that the quickſilver in the cylinder was frozen, and it is remarkable, it did not liquify in all that time.

The obſervations were made with the greateſt attention, and (on every particular occaſion) noted down as quick as poſſible.

Experiment III. made December 16, 1781.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″	B.	G.	E.	
8 55 55	34	35	—	Put them into the firſt freezing mixture uſed in the preceding experiment.
8 56 10	40	40	—	
8 56 21	41	41	—	
8 56 42	42	42	—	
8 57 0	43	42½	—	
8 57 26	43	43	—	
8 58 0	43	43	—	
8 58 58	54	43	—	
8 59 14	60	43	—	
8 59 40	64	43	—	
9 0 0	68	43	—	
9 0 34	70	43	—	
9 1 0	75	43	—	
9 1 22	78	43	—	
9 2 0	82	43	—	
9 2 30	85	43	—	
9 3 0	88	43	—	
9 4 0	94	43	—	Put the ſpirit thermometer (E) into the mixture.
9 4 21	94	43	27	
9 4 40	98	43	30	
9 5 12	100	43	31½	
9 6 0	104	43	32	
9 6 30	106	43	32	
9 7 0	108	43	32	
9 7 40	110	43	32	
9 8 20	112	43	—	
9 9 0	114	43	—	
9 10 30	116	40	—	The quickſilver in the apparatus was fluid, but ſeemed thick and in grains, ſomewhat like crumbs of bread; replaced it again, and went to breakfaſt.
9 50 0	40	40	—	Examined the quickſilver again, it was frozen hard.
10 55 40	—	37½	—	The quickſilver as fluid as ever.

This experiment was made during the continuance of that which immediately precedes it, as may be ſeen by examining

the time by the watch, and was the effect of chance; for the firſt freezing mixture, which had been uſed in the ſecond experiment, ſtanding in the glaſs cloſe to me (and the other inſtruments being long ſtationary, did not require particular attention), I took down the thermometer (G) and charged its cylinder with quickſilver, as in the other examples, and ſuſpended it in the old mixture, together with the mercurial thermometer (B) and a ſpirit thermometer; the mixture ſeemed to have loſt much of its coldneſs, as appeared by the thermometers. It ſeemed very extraordinary to me, that the apparatus, after having been ſo long ſtationary at 43°, ſhould yet contain fluid quickſilver; but both myſelf and aſſiſtant thought it was thicker than ordinary, as it did not run freely, but ſeemingly in pieces (not globules): however we put it back again into the mixture, and ſet it by as of no further uſe; but returning after breakfaſt, we found it was firmly frozen, ſo as to give no appearance of fluidity though the included thermometer was only at 40°, which I look upon to be the exact freezing point of quickſilver; and then the congelation was in fact begun before, and effected by only a longer continuance in the ſame degree of cold.

It may be neceſſary to mention, that the ſpace between the bottom of the ivory ſcale to the bulb of the thermometer (F) which made part of the apparatus uſed in the ſecond experiment, was two inches nine-tenths; and when taken with a pair of compaſſes (dividers) with one foot placed at the cypher o on the graduated ſcale, the other extended to 148° if meaſured upwards, and to 165° if meaſured downwards, for the diviſions were unequal.

Experiment IV. made January 7, 1782.

Time *per* watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
8 7 0	35	30	—	Put the inſtruments into a tumbler of ſnow.
8 9 45	35½	27	—	
8 10 40	—	—	—	Added the ſpirit of nitre.
8 11 0	42	42	—	Added more ſnow to increaſe the quantity of the mixture.
8 12 30	—	—	—	Added more ſpirit.
8 13 15	68	42	—	
8 13 35	78	42	—	
8 14 0	92	42	—	
8 14 15	100	42	—	
8 14 30	108	42	—	
8 14 45	116	42	—	
8 15 0	126	42	—	
8 15 15	134	42	—	
8 15 30	140	42	—	
8 15 45	146	41½	—	
8 16 20	160	41½	—	
8 16 30	166	41½	—	
8 16 45	171	41½	—	
8 17 15	182	41½	—	
8 17 45	191	41½	—	
8 18 0	196	41½	—	
8 18 15	202	41½	—	
8 18 30	208	41½	—	
8 18 45	212	41½	—	
8 19 30	232	77	—	The deſcent in the apparatus therm. very quick.
8 19 40	240	77	—	
8 20 30	258	77½	—	
8 20 40	262	77½	—	
8 21 0	270	77½	—	
8 21 15	278	77½	—	
8 21 45	280	77½	—	
8 22 0	286	77½	—	
8 22 30	293	77½	—	
8 22 35	298	77½	—	
8 23 0	302	78	—	
8 23 15	305	78	—	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Appara-tus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
8 23 30	309	78	—	
8 24 0	316	78	—	
8 24 15	319	78	—	
8 24 30	322	78	—	
8 24 45	327	78	—	
8 25 0	329	78	—	
8 25 15	332	78	—	
8 25 30	336	78	—	
8 25 45	338	78	—	
8 26 0	342	78	—	
8 26 15	345	78	—	
8 26 30	348	78	—	
8 26 45	351	78	—	
8 27 0	354	78	—	
8 27 15	356	78	—	
8 27 30	359	78	—	
8 27 45	361	78	—	
8 28 0	364	78	—	
8 28 15	366	78	—	
8 28 30	368	78	—	
8 28 45	370	78	—	
8 29 0	373	77	—	
8 29 15	376	77	—	
8 29 30	378	77	—	
8 29 45	380	77	—	Stirred the mixture.
8 30 15	386	77	—	
8 30 30	388	77	—	
8 31 0	392	77	—	
8 31 15	394	76½	—	
8 31 30	396	76½	—	
8 31 45	398	76½	—	
8 32 15	402	76½	—	
8 32 30	403	76	—	
8 32 45	404	76	—	
8 33 0	406	76	—	
8 33 15	408	76	—	Put in ſpirit thermometer (D).
8 34 0	412	76	31½	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
8 34 30	416	76	32	
8 35 0	418	76	32	
8 35 30	422	76	32	
8 36 0	424	76	32	
8 36 15	425	76	32	
8 36 30	425	76	32	
8 36 45	427	76	32	
8 37 0	428	76	32	
8 37 15	429	76	32	
8 37 30	430	76	32	
8 37 45	430	76	32	
8 38 0	431	76	32	
8 38 30	432	76	32	
8 38 45	433	76	32	
8 39 0	434	76	32	
8 39 15	435	76	32	
8 39 30	435½	76	32	
8 40 0	436	76	32	
8 40 30	436	76	32	
8 40 45	437	76	32	
8 41 15	438	76	32	
8 41 30	438½	76	32	
8 41 45	439	76	31½	
8 42 15	440	76	31½	
8 43 0	440	76	31½	
8 43 15	440	75½	31½	
8 44 30	440	75½	31	Made a fresh mixture.
8 47 0	438	75	31	Removed the instr. into the new freezing mixture.
8 47 36	448	76	34½	
8 48 0	448	76½	35	
8 48 30	448	77	35	
8 49 0	448	77	35	
8 49 30	449	77	35	
8 50 0	449	77	35	
8 50 30	450	77	35	
8 51 0	450	77	35	
8 52 0	450	77	35	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
8 53 0	45°	77	35	
8 54 0	45°	77	35	
8 56 0	45°	77	35	
8 57 0	45°	77	35	
8 58 0	45°	77	35	
8 59 0	45°	77	35	
9 0 0	45°	77	35	
9 1 0	45°	77	35	
9 2 0	45°	77	35	
9 3 0	45°	77	35	
9 4 0	45°	77	35	
9 5 0	45°	77	35	
9 6 0	45°	77	35	
9 7 0	45°	77	35	Examined the apparatus; found all ſolid.
9 8 0	45°	77	35	
9 9 0	45°	77	35	
9 10 0	45°	77	35	
9 11 0	45°	77	35	
9 12 0	45°	77	35	
9 13 0	45°	77	35	
9 14 0	45°	77	35	
9 15 0	45°	77	35	
9 16 0	45°	77	35	
9 17 0	45°	77	35	
9 18 0	45°	77	35	
9 19 0	45°	77	35	
9 20 0	45°	77	35	
9 21 0	45°	77	35	
9 22 0	45°	77	35	
9 23 0	45°	77	35	Added more ſnow.
9 23 30	45°	77	35	
9 24 0	45°	77	34½	
9 25 0	45°	77	34½	
9 26 0	45°	77	34½	
9 27 0	45°	77	34½	
9 28 0	45°	77	34½	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
9 29 0	450	77	34½	
9 30 0	450	77	34½	
9 31 0	450	77	34½	
9 32 0	450	77	34½	
9 33 0	450	77	34½	
9 34 0	450	77	34½	
9 35 0	450	77	34½	
9 36 0	450	77	34¼	
9 37 0	449	77	34	
9 38 0	449	77	33½	
9 39 0	449	77	33	
9 40 0	449	77	33	
9 41 0	449	77	32½	
9 42 0	449	77	32½	
9 43 0	448½	76	32½	
9 44 0	448½	76	32½	
9 45 0	448½	76	32½	
9 46 0	448½	76	32	
9 47 0	448½	76	32	
9 48 0	448½	76	32	
9 49 0	448½	76	32	
9 50 0	448½	76	31½	
9 51 0	448½	76	31½	
9 52 0	448	75½	31½	
9 53 0	448	75½	31½	
9 54 0	448	75	31¼	
9 56 0	448	75	31	
9 57 0	447	75	31	
9 58 0	445	75	30¾	
9 58 30	444	75	30¾	
9 58 45	443	75	30¾	
9 59 0	442	75	30¾	
9 59 15	441	75	30¾	
9 59 30	440	75	30½	
9 59 45	439	75	30½	
10 0 0	438	75	30½	
10 0 15	437	75	30½	

Experiment IV. made January 7, 1782.

Time per Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and obſervations.
h. ′ ″				
10 0 30	436	75	30½	
10 0 45	435	75	30½	
10 1 0	434	75	30½	
10 1 15	433	75	30½	
10 1 30	432	75	30¼	
10 1 45	431	75	30¼	
10 2 0	430	75	30	
10 2 15	429	75	30	
10 2 45	426	74	30	
10 3 30	422	74	30	
10 4 15	417	74	30	
10 4 45	414	74	30	
10 5 0	412	74	30	
10 5 30	408	73½	30	
10 6 0	405	73½	30	
10 6 30	401	73½	29½	Filled up the tumbler with a former mixture.
10 7 30	388	73	28½	
10 8 0	382	74	28	
10 8 30	377	82	28	
10 8 46	374	87	28	
10 9 0	368	110	28	
10 9 10	366	125	28	
10 9 20	364	170	28	
10 9 40	360	200	28	
10 9 50	358	240	28	
10 10 0	356	Bulb	28	
10 10 30	350	D°	28	
10 11 10	340	D°	28	
10 12 0	332	D°	28	
10 12 30	327	D°	28	
10 13 0	321	D°	28	
10 13 30	316	D°	28	
10 14 0	311	D°	28	
10 14 30	306	D°	28	
10 15 0	301	D°	28	
10 15 30	296	D°	28	Made a freſh mixture.
10 16 0	—	D°	28	Put the inſtruments into a freſh mixture.

Experiment

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
10 16 30	312	Bulb	29	
10 17 0	352	D°	35	
10 17 45	373	D°	35	
10 18 0	384	D°	35	
10 18 15	389	D°	35	
10 18 30	389	D°	35	
10 18 45	389	D°	35	
10 19 0	389	D°	35	
10 20 0	389	D°	35	
10 20 30	389	D°	35	
10 21 0	389	D°	35	
10 22 0	389	D°	35	
10 23 0	389	D°	35	
10 24 0	389	D°	35	
10 25 0	389	D°	35	
10 26 0	389	D°	35	
10 27 0	389	D°	35	
10 28 0	389	D°	35	
10 29 0	389	D°	35	
10 30 0	389	D°	35	
10 31 0	389	D°	35	
10 32 0	389	D°	35	
10 33 0	389	D°	35	
10 34 0	389	D°	35	
10 35 0	389	D°	35	
10 36 0	389	D°	35	
10 37 0	389	D°	35	
10 38 0	389	D°	35	
10 39 0	389	D°	35	
10 40 0	389	D°	35	
10 41 0	389	D°	35	
10 42 0	389	D°	35	
10 43 0	389	D°	35	
10 44 0	389	D°	$34\frac{1}{2}$	
10 45 0	389	D°	$34\frac{1}{2}$	
10 46 0	389	D°	$34\frac{1}{2}$	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
10 47 0	389	Bulb	34½	
10 48 0	389	D°	34½	
10 49 0	389	D°	34½	
10 50 0	389	D°	34	
10 51 0	389	D°	34	
10 52 0	389	D°	34	
10 53 0	288	D°	34	
10 55 0	288	D°	33½	
10 59 0	288	D°	33¼	
11 1 0	288	D°	33	
11 5 0	388	D°	32½	
11 10 0	388	D°	32	
11 15 0	444	D°	31½	
11 15 10	446	D°	31	
11 15 30	445	D°	31	
11 15 45	444	D°	31	
11 16 15	443	D°	31	
11 17 0	441	D°	31	
11 18 0	437	D°	31	
11 19 0	434	D°	30	
11 20 0	428	D°	30	
11 21 30	418	D°	29½	Whilſt examining the apparatus, part of the quickſilver turned fluid.
11 22 30	412	D°	29½	
11 23 0	408	D°	29½	
11 23 30	404	D°	29¼	
11 24 0	400	D°	29	
11 24 30	396	D°	29	
11 25 30	390	D°	29	The center of the quickſilver appeared globular and ſolid.
11 26 30	379	D°	29	
11 28 0	365	D°	29	
11 29 0	355	D°	29	
11 29 30	352	D°	29	
11 29 45	349	D°	29	
11 30 0	346	D°	29	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
11 30 15	344	Bulb	29	
11 30 30	342	D°	29	
11 30 45	339	D°	29	
11 31 0	336	D°	29	
11 31 15	333	D°	29	
11 31 30	330	D°	29	
11 31 45	328	D°	29	
11 32 0	325	D°	29	
11 32 30	320	D°	29	
11 32 45	318	D°	29	
11 33 0	314	D°	29	
11 33 15	312	D°	29	
11 33 30	309	D°	28½	
11 33 45	306	D°	28½	
11 34 0	303	D°	28½	
11 34 15	301	D°	28½	
11 34 30	298	D°	28½	
11 34 45	295	D°	28½	
11 35 0	292	D°	28½	
11 35 15	289	D°	28½	
11 35 30	286	D°	28½	
11 35 45	283	D°	28½	
11 36 0	280	D°	28½	
11 36 15	277	D°	28½	
11 36 30	274	D°	28½	
11 37 0	267	D°	28½	
11 37 15	264	D°	28½	
11 37 30	262	D°	28½	
11 37 45	258	D°	28¼	
11 38 0	255	D°	28	
11 38 15	252	D°	28	
11 38 30	249	D°	28	
11 38 45	246	D°	28	
11 39 0	241	D°	28	
11 39 30	237	D°	28	
11 39 45	234	D°	28	

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
11 40 0	231	D°	28	
11 40 30	224	D°	28	
11 41 0	216	D°	28	
11 41 30	211	D°	28	
11 42 0	204	D°	27½	
11 42 30	197	D°	27½	
11 43 0	190	D°	27½	
11 43 30	185	D°	27½	
11 44 0	178	D°	27½	
11 44 30	170	D°	27	
11 45 0	160	D°	27	
11 45 30	150	D°	27	
11 46 0	142	D°	27	
11 46 30	134	D°	27	
11 47 0	125	D°	27	
11 47 30	118	D°	27	
11 48 0	109	D°	27	
11 48 30	103	D°	27	
11 49 0	96	—	27	The quickſilver in the apparatus thermometer riſing faſt in the tube.
11 49 15	90	227	27	
11 49 30	88	215	27	
11 49 40	86	205	27	
11 49 50	84	193	27	
11 50 0	82	180	27	
11 50 10	80	170	27	
11 50 20	78	157	27	
11 50 30	73	145	27	
11 50 40	73	132	27	
11 50 50	72	120	27	
11 51 0	69	105	27	
11 51 10	68	88	27	
11 51 20	64	65	27	
11 51 35	62	45	27	
11 51 50	59	37½	27	
11 52 0	56	38	27	

Experiment

Experiment IV. made January 7, 1782.

Time *per* Watch.	Thermom. below 0.	Apparatus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
11 52 30	53	38	27	
11 53 0	46	38	27	
11 53 30	42	37	27	Found the quickſilver wholly thawed in the cylinder.
11 54 0	40	37	26½	
11 54 30	39	37	26½	
11 55 0	39	37	26½	
11 55 30	39	37	26½	
11 56 0	39	37	26½	
11 56 30	38	36	26	

This experiment was made with the mercurial thermometer (A) and the apparatus (F) as in the firſt and ſecond experiments. The day was clear, with little wind at W. by S. or W.S.W. which I have obſerved to be generally the caſe in this country in the coldeſt weather. The thermometers at 8 o'clock were as follows, according to the rotation of the letters from (A) to (G), 39°½, 36°½, 35°, 25°, 25°, 34°½, 34° below the cypher. The apparatus thermometer (F), after ſtanding at 42° and 41°½ for a conſiderable time, ſunk at once to 77°, not gradually or by jumps, but ſuddenly, as a weight falleth. The great deſcent of the quickſilver in the index thermometer (A) to 440° in the firſt freezing mixture I impute to the coldneſs of the weather, but was ſurpriſed to find it did not ſink more than 10° lower in the ſecond mixture; and in the third it did not reach ſo low as in the preceding, which, indeed, might be accounted for by the air growing warmer as the ſun approached the meridian. At 10 h. 6′½ I poured ſome of the firſt mixture into the tumbler where the inſtruments were immerſed in the ſecond, but found it weakened it; I therefore mixed a freſh one at 10 h. 16′. It is however remarkable, that after pouring in the firſt mixture

on the ſecond, the apparatus, which had riſen a little before, ſunk ſuddenly into the bulb. I have marked its progreſs as faſt as I could catch it. Another extraordinary circumſtance in this experiment is, that the mercurial thermometer (A) ſhould not ſubſide lower in the third than in the ſecond mixture; whereas the ſpirit thermometer ſhewed an equal degree of cold, while the quickſilver in the apparatus thermometer was in the bulb. At 11 h. 21′ I took the apparatus out to examine it, and, by ſhaking it in my hand, all of a ſudden ſome of the quickſilver in the cylinder liquified; the concuſſion perhaps diſſolved its ſolidity, for it was not above a minute out of the mixture. Wondering much at this unexpected phænomenon, as the quickſilver in the thermometer did not riſe, I put it into the mixture again immediately; but finding the incloſed thermometer ſhewed no alteration, my curioſity determined me to examine it again; therefore, about four minutes after, I took it out a ſecond time, and found the ſurface of the quickſilver in the cylinder was liquified about one-eighth of the whole quantity, as near as I could gueſs; the reſt formed a ſolid ball, including the bulb of the thermometer, which eaſily accounts for the quickſilver in that inſtrument remaining ſtationary. Wiſhing to obſerve the whole proceſs, and the cold being too ſevere for the ſame perſons to ſtand in the open air for ſo long a time, I deſired one of my officers, with an aſſiſtant, to mark down the obſervations at the times I went to warm myſelf, but by no means to make any alterations in my abſence; by this means the obſervations were continued regularly for near four hours.

At the end of the experiments the thermometers (B), (C), (D), and (G), ſtood as follows, 18°½, 15°, 9°½, 15, which ſhews the alteration in the temperature of the air from the beginning. The thermometers (A), (D), and (F), were uſed in the experiment.

Experiment

Experiment V. made February 22, 1781.

Time per Watch.	Thermom. below o.	Appara-tus.	Spirit Thermom.		Remarks and Occurrences.
h. ′ ″	A.	G.	C.		
8 4 0	78	40	29½		
8 9 0	89	40	29		Making the freezing mixture.
8 11 0	—	—	—		Put the inſtruments into the mixture.
8 11 10	70	40	31½		
8 11 30	60	39½	32		
8 11 50	54	39½	32		
8 12 30	—	—	—		Added more ſnow.
8 13 0	50	41	33½		
8 13 30	51	42	34		
8 14 0	51	72	34		
8 14 15	51	78	34		
8 14 32	51	78	34		
8 15 0	—	—	—		Added more ſnow.
8 15 20	52	78	35		
8 15 50	—	—	—		Added more ſnow.
8 16 10	52	79	35		The quickſilver in the cylinder fluid.
8 17 0	52	79	35		
8 20 0	52	79	35		
8 25 0	52	79	35		Made a freſh mixture.
8 30 0	52	79	35		Removed the inſtruments into the new mixture.
8 30 45	52	79	35		
8 31 30	52	79	35		The quickſilver in the cylinder ſtill fluid.
8 32 30	52	79	35	64	Put in mercurial thermometer (B).
8 32 50	52	79	35	80	
8 33 20	52	79	35	90	
8 34 0	52	79	35	90	
8 35 0	52	79	35	91	
8 37 0	52	79	35	91	The quickſilver in the cylinder ſolid frozen.
11 31 0	52	79	35	91	Took out all the inſtruments.

Remarks on the fifth experiment.

I had not intended to make any more experiments of this kind, thinking thoſe already made had fully determined the freez-

ing point of quickſilver; but the arrival of a gentleman, who wiſhed to ſee it, induced me to repeat it again. The weather was clear and ſerene, the wind about S.S.W., and the ſeveral thermometers ſtood as follows, A 82°, B 66°, D 34°, E 34°, F 42°, G 42°, H 46°, at ſeven o'clock in the morning; and at eight o'clock they were A 78°, B 114°, D 29°½, E 29°½, F 29°½, G 40°, H 43°; yet it is remarkable, that quickſilver which was conſtantly expoſed to the air in a ſaucer was not froze. I impute the ſmall deſcent of the quickſilver in the thermometers to the great degree of the cold in the atmoſphere as in the ſixth experiment, for there the effect was ſimilar. The moſt remarkable circumſtance in this day's operation was the ſudden deſcent of the quickſilver in the apparatus thermometer, and the length of time it continued at 79° before the quickſilver in the cylinder became ſolid. The freezing mixture retaining an equal degree of cold for ſo long a time (as appeared by the ſpirit thermometer), and the conſequent ſtationary ſituation of all the inſtruments, I apprehend, proceeded from the continual cold in the circum-ambient air; for at one o'clock the thermometers were riſen but very little, being as follows, A 35°, B 32°, D 21°, E 22°, F 30°, G 30°, H 34°, the wind blowing briſk from N.W.

Experiment

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Remarks and Occurrences.
h. ′ ″				
8 15 0	42	50	27½	The inſtruments juſt put into the freezing mixture.
8 15 50	43	70	33	
8 16 15	43	100	34	
8 16 45	44	120	34	
8 17 15	44	140	34	
8 17 30	44	150	34	
8 17 45	44	155	34	
8 18 30	45	170	34	The mixture did not cover the bulb of (H).
8 19 0	—	—	—	Added more ſnow and ſpirit.
8 20 20	44	170	34	
8 21 0	45	170	34	
8 22 15	46	170	33	
8 22 50	46	170	33¼	
8 23 30	46	170	33¼	
8 24 30	46	170	33¼	
8 25 10	46	171	33½	
8 26 0	46	171	33½	
8 27 10	46	172	33½	
8 27 45	46	172	33½	
8 29 30	46	172	33½	Added more ſnow.
8 30 30	46	172	33½	
8 35 0	46	172	33½	Made a freſh mixture.
8 36 0	46	173	34½	Put the inſtruments into a freſh mixture.
8 36 30	46	173	34½	
8 37 0	46	173	34½	
8 37 30	46½	173	34½	
8 38 30	47	174	35	
8 39 40	47	174	35	
8 40 30	47½	174	35	
8 41 15	48	174	35	
8 42 0	48	175	35	
8 43 0	48	175	35	
8 44 0	48	175	35	
8 45 0	48	175	35	
8 45 15	47½	175	35	
8 46 0	47½	175	35	
8 46 30	47½	175	35	

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. C.	Mercurial th. A and B.	Remarks and Occurrences.	Mer. ther. A in air.
h. ′ ″				A.		
8 47 30	47½	174	34½			
8 48 0	47½	174	34½	45	Put mercurial th. (A) into the mixture.	
8 50 0	47½	174	35	76		
8 50 30	47½	174	35	114		
8 50 45	47½	174	35	124		
8 51 0	47½	174	35	146		
8 51 30	47½	174	35	147		
8 52 30	47½	174	35	147		
8 53 30	47½	174	35	147½		
8 54 0	47½	174	35	147½		
8 55 0	47½	174	35	147½		
8 56 0	47½	174	35	147½		
8 56 30	47½	174	35	147½		
8 57 35	47½	175	35	148		
8 58 0	48	175	35	148		
8 59 0	48	175	35	148		
9 0 0	48	175	35	148		
9 1 0	48	175	35	148		
9 2 0	48	175	35	148		
9 3 0	48	175	35	148		
9 4 0	48	175	35	148		
9 5 0	48	175	35	148	Took out thermometer (A).	148
				B.		
9 8 0	48	174	35	70	Put in mercurial thermometer (B).	148
9 9 45	48	174	35	84		148
9 10 15	48	174	35	86		148
9 11 0	48	174	35	86	Added more ſnow.	148
9 13 0	48	173	35	86		148
9 15 0	47	173	34¾	86		148
9 16 0	47	173	34½	86		148
9 17 0	46½	173	34½	86		148
9 18 0	46½	173	34¼	86		148
9 19 30	47	174	34	86		148
9 20 30	47	174	34	86		147
9 22 30	47	174	34	86		147
9 23 30	47	173	34	86		146
9 24 30	47	173	34¼	86		145½

Experiment VI. made January 11, 1782.

Time *per* watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Mercurial therm. B.	Remarks and Occurrences.	Mer. ther. A in air.
h. ′ ″						
9 25 30	47	173	34½	86	Sunk inſtantaneouſly.	438
9 26 30	47	173	34½	86		436
9 27 45	47	173	34½	86		436
9 28 30	46	174	34½	86		435
9 29 15	46	173	34½	86		433
9 30 0	46	173	34½	86		432⅕
9 31 0	46	172	34½	86		432
9 31 45	46	172	34½	86		430
9 33 40	47	174	34½	86		430
9 34 30	47	174	34½	86	I ſuſpect this variation to have been occaſioned by different perſons reading off the numbers.	430
9 35 30	47	173	34½	86		428
9 36 0	47	173	34½	86		426
9 37 0	47	173	34½	86		426
9 38 0	47	173	34½	86		426
9 39 0	47	173	34½	86		425
9 40 0	47	173	34½	86		424
9 41 0	47	173	34½	86		424
9 42 0	47	173	34½	86		423
9 43 0	47	173	34½	86		422
9 45 0	47	172	34	86		420
9 48 0	47	172	34	86	Put in apparatus (F) at −40°.	412
9 49 0	47	172	34	86		412
9 50 0	47	172	34	86	Took out apparatus (F) ſolid −40°.	412
9 51 0	47	172	34	86	Put in apparatus (G) fell directly to −210°.	410
2 53 0	47	172	34	86	Took out ditto, ſolid at 210°.	405
9 55 0	47	172	34	86		402
9 56 0	47	172	34	86		401
9 57 0	47	172	34½	86		400
9 58 0	47	172	34½	86		398
9 59 0	47	172	34½	86		396
10 0 0	47	172	34½	86		394
10 1 0	47	172	34½	86		392
10 2 0	47	172	34½	86		390
10 3 0	47	172	34½	86		388
10 4 0	47	172	34½	86		386

Experiment

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Mercurial therm. B.	Remarks and Occurrences.	Mercurial B in air.
h. ′ ″						
10 5 0	47	172	34	86		384
10 6 0	47	172	34	86	Apparatus (G) in the bulb, in open air, ſince 9 h. 53′.	382
10 9 0	47	172	34	86		372
10 10 0	47	172	34	86		370
10 11 0	47	172	34	86		366
10 13 0	47	172	34	86		362
10 14 0	47	172	34	86		360
10 15 0	47	172	34	86		358
10 16 0	47	172	34	86		356
10 17 0	47	172	34	86		353
10 18 0	47	172	34	86		351
10 19 0	47	172	34	86		348
10 20 0	47	172	33½	86		346
10 21 0	47	172	33½	86		342
10 22 0	47	172	33½	86		340
10 23 0	47	172	33½	86		338
10 24 0	47	171	33½	86		334
10 25 0	47	171	33½	86		332
10 26 0	47	171	33½	86		330
10 27 0	47	171	34	86		328
10 28 0	47	171	34	86		324
10 29 0	47	171	34	86		320
10 30 0	47	171	34	86		316
10 31 0	47	171	34	86		314
10 32 0	47	171	34	86		300
10 32 30	47	171	34	86		298
10 33 0	47	171	34	86		280
10 33 30	47	171	34	86		274
10 34 0	46	171	34	86		272
10 35 0	46	171	34	86		268
10 36 0	46	171	34	86		264
10 37 0	46	171	34	86		262
10 38 0	46	171	34	86		260
10 39 0	46	171	34	86		258
10 40 0	46	171	33½	86		254
10 41 0	46	171	33	86		246

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Mercurial therm. B.	Remarks and Occurrences.	A in air. Mer. ther.
h. ′ ″						
10 42 0	46	171	32½	86		244
10 43 0	46	170	32½	86		238
10 44 0	46	170	32½	86		234
10 45 0	46	170	32½	86		230
10 46 0	46	170	32¼	86		228
10 47 0	46	170	32¼	86	External part of quickſilver in the apparatus (F) fluid, the center a globular ſolid. In the open air an hour.	224
10 49 0	46	170	32¼	86		214
10 50 0	46	170	32¼	86		213
10 51 0	46	170	32¼	86		208
10 52 0	46	170	32	86		206
10 53 0	46	170	32	86		200
10 54 0	45	170	32	86		196
10 55 0	45	170	32	86		192
10 56 0	45	170	32	86		190
10 57 0	45	170	32	86		186
10 58 0	45	170	31½	86		176
10 59 0	45	170	31½	86		166
11 0 0	45	170	31½	86	A portion of quickſilver in apparatus (F) ſtill frozen.	160
11 5 0	44	170	31	85		134
11 6 0	44	170	31	85		128
11 7 0	44	170	31	85		126
11 8 0	44	170	31½	86		124
11 9 0	44	170	31½	86		116
11 10 0	44	170	31½	86		116
11 11 0	44	170	31½	86		110
11 12 0	44	170	31½	86		100
11 13 0	44	170	31½	86		96
11 14 0	44	170	31½	86		92
11 15 0	44	170	31½	86		84
11 16 0	44	170	31½	86		82
11 17 0	44	170	31	85		78
11 18 0	44	170	30½	85		68
11 19 0	44	166	30¼	85		60
11 20 0	44	167	30	85		54

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard Spirit H.	Mercurial therm. C.	Spirit therm. D.	Mercurial therm. B.	Remarks and obſervations.	Mer. ther. A in air.
h. ′ ″						
11 22 0	43	167	30	85		48
11 23 0	43	167	30	85		44
11 25 0	43	167	30	85		42
11 26 0	43	167	30	85		40
11 27 0	43	167	30	85		40
11 28 0	43	167	30	85		40
11 29 0	43	167	30	85		40
11 30 0	43	167	30	85		40
11 31 0	43	167	30	85		40
11 32 0	43	167	30	85		38
11 33 0	43	167	29½	85		36
11 34 0	43	167	29½	85		36
11 35 0	43	167	29½	85		36
11 36 0	43	167	29½	85		36
11 37 0	43	167	29½	85		36
11 38 0	43	167	29½	85		36
11 39 0	43	167	29½	85		36
11 40 0	43	167	29½	85		36
11 42 0	43	167	29½	85		36
11 44 0	43	167	29½	85		36
11 46 0	43	167	29½	85		34
11 48 0	42½	166	29	85		34
11 49 0	42	165	28½	434	The quickſilver in thermometer (B) ſunk in an inſtant.	34
11 51 0	42	165	28½	432		34
11 52 0	42	165	28½	432		34
11 53 0	42	165	28½	432		34
11 53 30	42	165	28	430		34
11 54 0	42	166	28	427		
11 55 0	42	315	28	425	The quickſilver in thermometer (C) ſubſided all at once.	
11 56 0	41	360	28	422		
11 57 0	41	360	28	420		
11 58 0	40½	358	28	417		
11 58 30	40½	355	27½	415		
11 59 0	40	352	27½	413		

Experiment

Experiment VI. made January 11, 1782.

Time *per* Watch.			Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Mercurial therm. B.	Remarks and Occurrences.
h.	′	″					
12	0	0	40	350	27¼	408	
12	1	0	40	345	27¼	404	
12	2	0	40	336	27	398	
12	3	0	40	330	27	394	
12	4	0	40	323	27	390	
12	5	0	40	315	27	384	
12	6	0	40	309	27	379	
12	7	0	40	300	27	374	
12	8	0	40	294	27	368	
12	9	0	40	285	27	362	
12	10	0	40	275	27	355	
12	12	0	40	257	27	343	
12	13	0	40	245	27	335	
12	14	0	40	235	26½	329	
12	15	0	40	222	26½	320	Made a freſh mixture.
12	16	0	—	—	—	—	Put the inſtruments into the freſh mixture.
12	16	30	40½	270	33	340	
12	17	0	42	335	33	340	
12	17	30	42	365	33	340	
12	18	0	42	370	33½	340	
12	18	30	42	372	33½	340	
12	19	0	42½	372	33½	340	
12	20	0	43	372	33½	340	
12	21	0	43	372	33½	340	
12	22	0	43	372	33½	340	
12	24	0	43	374	33½	340	
12	26	0	43	374	33	340	
12	28	0	43	374	33	340	
12	32	0	43	374	33	340	
12	37	0	43	374	33	340	
12	42	0	43	374	32	340	
12	45	0	43	374	32	340	
12	54	0	43	374	32	340	
12	59	0	43	374	32	340	
1	0	0	43	374	32	340	

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Mercurial therm. B.	Remarks and Occurrences.
h. ′ ″					
1 5 0	42	373	30	340	
1 10 0	42	371	29	340	
1 14 0	41½	370	29	340	
1 19 0	41	370	28½	340	
1 21 0	41	370	29	340	Added ſnow, the mixture growing thin.
1 23 0	41	370	29	340	
1 26 0	41	370	28½	340	
1 30 0	40½	370	28	340	
1 35 0	40	370	28	340	
1 40 0	40	370	28	340	
1 45 0	40	360	27	340	
1 46 30	40	—	27	400	
1 46 45	40	—	27	410	
1 47 0	40	—	27	438	
1 49 0	39	335	26½	433	
1 50 0	39	322	26	428	
1 51 0	38	312	26	423	
1 54 0	38	291	26½	413	
1 55 0	38	280	26½	408	
1 56 0	38	273	26½	403	
1 57 0	38	266	26½	398	
1 58 0	38	259	26½	394	
1 59 0	38	253	26½	388	
2 0 0	38	241	26½	382	
2 1 0	38	232	26½	376	
2 2 0	38	225	26½	371	
2 3 0	38	212	26½	363	
2 4 0	38	202	26½	357	
2 5 0	38	193	26½	350	
2 6 0	37½	180	26½	341	
2 7 0	37½	167	26½	332	
2 8 0	37½	158	26	328	
2 9 0	38	145	26	320	
2 10 0	38	132	26	310	
2 11 0	38	123	26	304	
2 12 0	38	105	26	300	

Experiment VI. made January 11, 1782.

Time *per* Watch.	Standard ſpirit H.	therm. C. Mercurial	Spirit therm. D.	Mercurial therm. B.	Remarks and Occurrences.
h. ′ ″					
2 13 0	38	80	26	282	
2 14 0	38	55	26	276	
2 15 0	38	37	26	270	
2 16 0	38	45	26	262	
2 17 0	38	35	26	252	
2 18 0	38	35	26	250	
2 19 0	37½	34	26	244	Took out all the inſtruments.

This ſingular experiment, though it did not anſwer the intention for which it was principally deſigned, yet afforded many ſtriking phænomena which I ſhall mention in the courſe of theſe remarks. After a cold night, the quickſilver in the thermometer was at 44° below 0 at ſeven o'clock in the morning: thinking this great degree of cold was the moſt favourable opportunity of obſerving how low it was poſſible to make the quickſilver deſcend in the tube of the thermometers, I reſolved to embrace it, and at the ſame time to obſerve the concurrent degrees with a ſpirit thermometer; but as thoſe ſent out to me in 1781 (D and E) differed ſo much from the thermometers of quickſilver, I reſolved to make uſe of another ſpirit thermometer made by NAIRNE and BLOUNT, and which was alſo furniſhed me by the Royal Society in 1774. With this inſtrument, which I call the ſtandard, and marked with the letter H, I have made obſervations eight years, and found it agree very well with others made of quickſilver; and the more readily to diſcover the variation of (D), I employed it alſo in the ſame experiment; but before I began the following obſervations

were taken, the inſtruments all expoſed to the open air, where they are continually kept. The thermometers are marked from (A) to (H), and the obſervations are regularly in that order.

h. ,	A	B	C	D	E	F	G	H
7 45	44½	45	41	28	29	40	40	46
7 50	46	64	124	30	32	42	41	46
7 55	—	—	60	—	—	—	—	—
7 57	44	—	—	—	—	—	—	—

It is obſervable, that neither the quickſilver which was in the cylinders affixed to (F) and (G), nor the other quickſilver which I conſtantly kept in the ſame place, ſome in a ſaucer, ſome in a gallipot, and ſome in a phial, ſhewed the leaſt appearance of congelation. Being engaged in preparing for the enſuing experiment, I did not remark either the great deſcent or aſcent of the quickſilver in (C), which muſt have been very ſudden, as my remarks are only five minutes aſunder.

It may be neceſſary to mention, that the thermometer (H) was mounted on a ſcale the whole length (as uſual for meteorological obſervations), and (C) was armed with elaſtic gum from the bulb to about half or three-quarters of an inch above the ſurface of the freezing mixture.

The ſmall deſcent of the quickſilver in (C), and the little effect produced by moving it into a ſecond mixture, made me at firſt apprehend the inſtrument was damaged; I did not, however, take it out, but took another thermometer (A), and put it alſo in the mixture; but I find it was ſtationary at a higher degree than (C): I therefore exchanged (A) for the mercurial thermometer (B), which to my great ſurprize was ſtationary at 86°, nor could it be got lower until the cold of the mixture diminiſhing it fell

at

at once to 434°, and a few minutes afterwards (C) fell to 360°. Imagining that a new mixture would now bring it very low, I made another, but in the mean time the inſtruments had riſen greatly, and after ſtanding in the freſh mixture (C) ſunk to 374°, and (B) to 438°. I ſhould have mentioned, that theſe mixtures were double in quantity to thoſe uſed in the former experiments; inſtead of glaſs tumblers, they were made in pint baſons.

I obſerved alſo, that the mixtures ſeemed to grow thin ſooner than common; for I always made them of the conſiſtence of pap. I added ſnow at times, to thicken it, but found it had very little effect, but rather decreaſed the cold. It is with great diffidence I offer it as my opinion, that the temperature of the air was too cold, and that the quickſilver being nearly in a ſtate of congelation before plunged into the mixture, was inſtantly frozen on putting the inſtruments into them; and as the quickſilver in the tubes muſt have been of the ſame temperature with that in the bulbs of the thermometers before the experiment, I ſhould imagine, that when the quickſilver in the bulb was frozen ſolid, it communicated an addition of cold to that in the tube, and froze it alſo, which prevented its ſubſiding as uſual; for in other caſes, the contraction of the quickſilver, when ſolid in the bulb, was the cauſe of the quickſilver ſubſiding in the tube; but then the latter was fluid, for the circumambient air was warmer than the degree at which quickſilver freezes, and the increaſed cold was applied only to the bulb. The obſervations made before the experiment began, as related in the beginning of theſe remarks, ſhew the quickſilver in the thermometer was congealing, and that (A) and (C) were actually frozen.

When

When I removed the thermometer (A) out of the mixture at 9 h. 5′, I hung it up in the air, and have noted down, in a ſeparate column on the right-hand ſide of the page, its appearances correſponding to the times put down on the other ſide of the page. It is remarkable, that (A) and (C) have each an air-bubble blown at the top; but the thermometer (B) had none.

Whilſt the inſtruments were ſtationary in the foregoing experiment, I put the apparatus (F) and (G) ſeverally into the mixture with the others; the conſequence was, that in two minutes the quickſilver in the cylinder was frozen ſolid; but as there was a difference in the effect I ſhall be more particular. At 9 h. 48′ put in apparatus (F), when it ſtood in the air at 40° or 41° below 0; and at 9 h. 50′ took it out frozen ſolid, and the incloſed thermometer pointing ſtill at 40° or 41°. I then hung it up in the open air, and looked at it only now and then. At 10 h. 47′ (after being expoſed to the air near an hour), I found only a ſmall quantity of the ſurface of the quickſilver was fluid, the reſt was a frozen globe reſembling a ball of poliſhed ſilver; the thermometer incloſed was ſtill at 40°. At 11 h. 4′ I obſerved a ſegment of a globe of ſolid quickſilver; in the inſide was a concavity made, I ſuppoſed, by the bulb of the thermometer. The thermometer was ſtill at 40°, which undoubtedly is the freezing point of quickſilver, as in this inſtance part of it was frozen, and part ſolid. I withdrew the thermometer, poured out the fluid quickſilver, and returned the thermometer into the cylinder, ſhortly after which it was at 37°, and the frozen ſegment was then fluid.

The apparatus (G) was hanging in the open air at 40°, and put into the ſame freezing mixture at 9 h. 51′, on which it ſunk inſtantly to 210°, at which degree it was ſtationary at

9 h.

9 h. 53′, when it was taken out of the mixture perfectly ſolid. At 10 h. 6′ I ſaw it had ſubſided into the bulb (I mean the quickſilver in the incloſed thermometer) which was the laſt time I particularly noticed it. It may be neceſſary to mention, that finding the quickſilver in the encloſed thermometer ſink inſtantaneouſly as ſoon as the apparatus was put into the freezing mixture, I took it out immediately, to view it, and replaced it in a few ſeconds of time. I found the quickſilver was not yet ſolid, but was in frozen pieces of irregular ſhapes, reſembling ice that had been broken to pieces by concuſſion in a pail of water, but with this remarkable difference, that as ice ſwims on the water, the frozen quickſilver ſubſided in fluid quickſilver, and the ſegment of ice, mentioned a little before to be found in the thermometer (F) was alſo at the bottom of the cylinder, and remained there after decanting the liquid quickſilver from it. Hence we may conclude, that cold increaſes the gravity of quickſilver, as indeed muſt be the caſe, ſince it is certain it occupies leſs ſpace in a ſolid than in a fluid ſtate.

Experiment

Experiment VII. made January 22, 1782.

Time *per* Watch.	Standard ſpirit E.	Mercurial therm. C.	Spirit therm. D.	Remarks and Occurrences.
h. ′ ″				
8 42 0	—	—	—	Making the freſh mixture.
8 45 0	—	—	—	Put in the inſtruments.
8 45 30	38	65	31½	
8 46 0	41	105	33	
8 46 15	42	130	33	
8 46 30	43	155	33½	
8 46 45	44	183	33½	
8 47 15	44	207	33½	
8 47 45	44	235	34	
8 48 0	44½	235	34	
8 48 30	45	235	34	
8 49 0	45	235	34	
8 50 0	45	235	34	
8 51 0	45	235	34	
8 52 0	46	237	34	
8 53 0	46	238	34	
8 54 0	46	238	34	
8 55 0	46	238	34	
8 56 0	46	237	34	
8 57 0	46	237	34	
8 58 0	46	236	34	
9 0 0	46	236	34	Making a freſh mixture.
9 4 0	45½	236	33	
9 5 0	—	—	—	Removed the inſtruments into the new mixture.
9 5 15	44	235	32	
9 5 45	44	237	32	
9 6 0	44½	237	31	
9 8 0	—	—	—	Put in apparatus (G).
9 9 0	—	—	—	(G) ſunk into the bulb, quickſilver in the cylinder fluid.
9 11 0	44½	237	30½	
9 13 0	44½	237	29½	
9 15 0	44½	237	29½	
9 16 0	44½	237	29½	
9 17 0	44	237	29½	
9 18 0	44	237	29½	
9 19 0	43½	237	29½	

Experiment VII. made January 22, 1782.

Time *per* Watch.	Standard spirit H.	Mercurial therm. C.	Spirit therm. D.	Remarks and Occurrences.
h. ′ ″				
9 20 0	43½	237	29½	
9 21 0	43½	237	29	
9 22 0	33	236	29	Examined (G) remains as the laſt time.
9 23 0	42½	236	29	
9 24 0	42½	235	29	
9 25 0	42½	235	29	(G) remains ſtill the ſame.
9 26 0	42½	235	29	
9 27 0	42	235	29	
9 28 0	42	234½	29	
9 29 0	42	234	29	
9 30 0	42	234	29	
9 31 0	41½	234	29	
9 32 0	41	234	29	
9 33 0	41	234	29	
9 34 0	41	234	28½	
9 35 0	41	234	28½	
9 36 0	41	234	28½	
9 37 0	40½	234	28½	
9 38 0	40½	234	28	
9 39 0	40½	234	27½	
9 40 0	40	234	27	
9 41 0	40	234	27	
9 42 0	40	234	26½	
9 43 0	40	233	26½	
9 44 0	40	232	26½	
9 45 0	40	232	26½	
9 46 0	39½	232	26½	
9 47 0	39½	232	26½	
9 48 0	39	232	26	
9 49 0	39	231½	26	(G) remains in the bulb, quick. in the cylinder fluid.
9 50 0	39	231½	26	
9 50 30	39½	231	26	
9 51 0	39	232	26	
9 52 0	39	650	26	
9 52 20	—	850	—	
9 52 30	—	1050	—	
9 52 40	—	1120	—	

Experiment VII. made January 22, 1782.

Time *per* Watch.	Standard ſpirit H.	Mercurial therm. C.	Spirit therm. D.	Remarks and Occurrences.
h. ′ ″				
9 52 50	—	1300	—	
9 53 0	—	1350	—	
9 53 10	—	1360	—	
9 53 30	38	1361	26	
9 54 0	38	1361	26	Apparatus (G) as before; took it out entirely.
9 56 0	38	1362	25½	
9 57 0	38	1362	25½	Made a freſh mixture.
9 58 30	38	1305	31	Put the inſtruments into the new mixture.
9 59 30	39	1305	32	
10 0 0	40	1305	32	
10 0 30	40	1305	32	
10 1 0	40	1306	32	
10 2 0	40	1306	32	
10 3 0	40	1306	32	
10 4 0	40	1307	32	
10 5 0	40	1306	32	
10 6 0	40	1306	31½	
10 7 0	40	1306	31½	
10 8 0	40	1306	31½	
10 9 0	40	1307	31	
10 10 0	40	1307	31	
10 11 0	40	1307	31	
10 12 0	39½	1307	30½	
10 13 0	39½	1307	30½	
10 14 0	39	1306	30	
0 15 0	39	1306	30	Found (C) has loſt its bulb in the former mixture.

Remarks on the ſeventh experiment.

From the ſixth experiment I was induced to think, that the nearer the temperature of the atmoſphere approached to the freezing point of quickſilver, ſo that a great degree of cold might be communicated to the bulb of a thermometer and yet the quickſilver in the tube remain fluid, would be the pro-

pereſt

pereſt time for aſcertaining in this manner to what degree quickſilver will contract by the application of cold. With this view this ſeventh experiment was made: the ſeveral thermometers from A to H were as follows, before I began, A 38, B 36, C 33, D 24, E 24½, F 33, G 33, H 37. Thoſe uſed in the experiment were C, D and H. The firſt was to ſhew the deſcent of the quickſilver; and the two laſt, which were ſpirit thermometers, were employed to ſhew the correſponding contractions of the two ſubſtances, quickſilver and alcohol. After above an hour's attendance on them, I was highly pleaſed to ſee the quickſilver fall to 1367° below the cypher, eſpecially as I ſuppoſed, by changing the mixture for a freſh one, I ſhould get it much lower ſtill. I made another accordingly, and removed the inſtruments into it. The quickſilver roſe, as was common in changing the mixtures; but after waiting a conſiderable time, without its deſcending again, I recollected Profeſſor BRAUN mentioning that his thermometers were always broken when below 600°. This made me examine mine, and I found the bulb was broken and fallen off; and on a diligent ſearch in the mixture, I could not find either quickſilver or the pieces of glaſs; I therefore conclude it had dropped off into the other mixture, which unluckily I had thrown away the moment before, having occaſion to uſe the baſon in decanting the preſent mixture: I have no doubt but it broke at the time the quickſilver fell ſo rapidly. During the courſe of this experiment I put the apparatus (G) into the freezing mixture; in a minute's time the quickſilver in the incloſed thermometer had ſubſided into the bulb, and remained ſo during the time it continued immerſed in the freezing mixture, which was about three quarters of an hour; but though the thermometer, which made part of the apparatus, ſhewed ſo great a degree of cold,

yet the quickſilver in the cylinder was never frozen; and indeed the ſpirit thermometers, ſuſpended in the mixture, ſeemed to indicate, that there was not ſufficient cold to freeze quickſilver, except at the beginning; for I obſerve, it is not effected at 40°, without continuing ſome time at that degree, as appears very clearly from the third experiment.

Experiment VIII. made December 21, 1781.

Time *per* Watch.	Mercurial thermom.	Appara-tus.	Spirit Thermom.	Remarks and Occurrences.
h. ′ ″				
10 10 0	—	—	—	Made the freezing mixture.
10 12 0	—	—	—	Put in the gallipot of quickſilver.
10 13 0	—	—	—	Put thermometer (B) into the quickſilver.
10 13 30	—	35	—	
10 13 35	—	36	—	
10 13 40	—	37	—	
10 14 0	—	37	—	Put thermometer (A) into the freezing mixture.
10 14 30	30	38	—	
10 14 40	40	38	—	
10 15 0	42	38	—	
10 15 15	43	39	—	
10 15 30	44	39	—	
10 16 0	48	39	—	
10 16 15	56	39	—	
10 16 30	64	39	—	
10 16 45	70	39	—	
10 17 0	76	39	—	
10 17 15	81	39	—	
10 17 30	87	39	—	
10 17 45	92	39	—	
10 18 0	97	39	—	
10 18 15	102	39	—	
10 18 30	108	39	—	
10 18 45	113	39	—	
10 19 0	118	39	—	
10 19 15	122	39	—	
10 19 30	126	39	—	
10 19 45	130	39	—	

Experiment

Experiment VIII. made December 21, 1781.

Time *per* Watch.	Mercurial thermom.	Apparatus.	Spirit thermom.	Remarks and Occurrences.
h. ′ ″				
10 20 0	136	39	—	
10 20 15	139	39	—	
10 20 30	143	39	—	
10 20 45	147	39	—	
10 21 0	151	39	—	
10 21 15	154	39	—	
10 21 30	159	39	—	
10 21 45	163	39	—	
10 22 0	166	39	—	
10 22 15	169	39	—	
10 22 30	173	39	—	
10 22 45	175	39	—	
10 23 0	178	39	—	
10 23 15	182	39	—	
10 23 30	185	39	—	
10 23 45	187	39	—	
10 24 0	189	39	—	
10 24 15	192	39	—	
10 24 45	197	39	—	
10 25 0	199	39	—	
10 25 15	201	39	—	
10 25 45	188	39	—	Thermometer (A) flipped into the gallipot containing the quickfilver, by accident; replaced it.
10 27 15	200	39	—	
10 30 45	127	39	—	
10 31 0	122	39	—	
10 32 0	—	—	—	Put a fpirit thermometer into the mixture.
10 32 30	96	39	27	
10 33 0	86	39	27	
10 33 30	80	39	27½	
10 33 45	72	40	27½	
10 34 30	58	40	27	Made another mixture.
10 38 45	38	40	27	Took out the inſtruments.
10 40 0	—	—	—	Changed the mixture.
10 40 30	59	41	—	
10 40 45	63	41	—	
10 41 0	67	41½	—	

Experiment VIII. made December 21, 1781.

Time *per* Watch.	Mercurial thermom.	Appara-tus.	Spirit thermom.	Remarks and Occurrences.
h. ′ ″				
10 41 10	70	41½	—	Put in the ſpirit thermometer.
10 41 30	78	41½	29	
10 42 0	84	41½	30½	
10 42 15	88	41½	31	
10 42 30	91	41½	31	
10 43 0	95	41	31	
10 43 15	99	41	31	
10 43 30	100	41	31	
10 43 45	101	41	31	
10 44 0	101	41	31	
10 44 30	101	41	31	
10 45 15	101	40½	31	
10 46 0	101	40	30¾	
10 47 0	101	40	30½	
10 47 30	101	40	30½	
10 48 0	101	40	30¼	
10 48 30	101	40	30	
10 49 0	101	40	30	
10 49 30	101	40	29¾	
10 50 0	101	40	29¾	
10 50 30	101	40	29½	
10 51 0	101	39½	29¼	
10 51 30	101	39½	29¼	
10 52 0	101	39¼	29	
10 52 30	101	39¼	29	
10 53 0	101	39	29	
10 54 0	113	39	29	The deſcent in the mercurial therm. was ſudden.
10 54 30	112	39	29	
10 54 45	111	39	28¾	
10 55 0	110	39	28¾	
10 55 30	108	39	28½	
10 55 45	106	38¾	28½	
10 56 0	104	38½	28¼	
10 56 30	102	38½	28¼	
10 57 0	99	38½	28¼	
10 57 30	96	38½	28	
10 58 0	93	38¼	27¾	

Experiment VIII. made December 21, 1781.

Time *per* watch.	Mercurial thermom.	Apparatus.	Spirit thermom.	Remarks and Occurrences.
h. ′ ″				
10 58 30	89	38¼	27¾	
10 59 0	85	38	27½	
10 59 30	82	38	27½	
11 0 0	78	38	27½	Stirred the mixture.
11 0 30	75	38	27½	
11 1 0	70	38	27½	
11 1 30	66	38	27½	
11 2 0	64	38	27¼	
11 2 30	60	38	27¼	Stirred the mixture.
11 3 0	55	38	27¼	
11 3 30	51	37¾	27	
11 4 0	45	37¼	27	
11 4 30	44	37	27	

This eighth experiment was made with a view to try, whether quickſilver would freeze whilſt in contact with the freezing mixture. For this purpoſe I did not uſe the apparatus employed in the other examples, but ſubſtituted another, by taking a gallipot made of flint ſtone (as being thinner than the common ſort) of about an ounce meaſure, and filled it half full of quickſilver, into which I inſerted the mercurial thermometer (B) and employed the other mercurial thermometer (A) as an index, as before. I hoped by this means to determine exactly when the quickſilver was congealed, as I had free acceſs to it at all times, which was not the caſe when incloſed in the cylindrical glaſs, the worſted wound round the tube of the ivory thermometer to exclude the air, equally excluding any inſtrument from being introduced to touch the quickſilver. I made a kind of ſkewer, with a flat blunt point, of dried cedar wood

wood for lightneſs, which I found would remain in the gelatinous freezing mixture at any depth I choſe; but when inſerted into the quickſilver contained in the gallipot, the great diſproportion of gravity made it rebound upwards, and by the touch I could eaſily perceive, by the reſiſtance it met with, whether it proceeded from quickſilver in a fluid or congealed ſtate. The event did not anſwer my wiſhes, for I could not find that the quickſilver was frozen in the leaſt during the trial. Indeed the temperature of the air was not favourable, being under 20° below the cypher. The large quantity too of the quickſilver in the gallipot, as well as the thickneſs of that veſſel, might both of them contribute to render the operation unſucceſsful; yet, as the apparatus thermometer ſhewed the ſame degree (−40) as when quickſilver froze in the glaſs cylinder, I am of opinion it would congeal by this ſimple method in very cold weather, and a long continued application of a proper degree of cold by the mixtures.

Experiment IX. made February 22, 1782.

Whilſt I was attending on the preceding experiment (the 5th) and had removed the inſtruments into a ſecond mixture, the former one by this means being unemployed, I put into it a gallipot (the ſame I uſed in the eighth experiment) with about three quarters of a pound of quickſilver, and let it remain immerſed in the mixture a conſiderable time (I ſuppoſe near half an hour), and finding, by touching with a quill, that part of it was congealed, I drew the gallipot out, it being previouſly ſlung with a ſtring, and decanted off the ſuperincumbent mixture and fluid quickſilver; the remainder, about two-thirds of the whole quantity, remained ſolid in the gallipot;

pot; the internal ſurface remained every where very rough and white, ſhining like an old ſilver ſpoon long in uſe and having loſt its poliſh. Part of it became fluid in a few minutes; and imagining it afforded a fine opportunity of confirming what had before appeared to be the freezing point of quickſilver, I put a mercurial thermometer (F) which then ſtood at 34°, into the part of the quickſilver in the gallipot, which was juſt thawed, and it ſubſided directly to −40°, and became ſtationary. I repeated the ſame with another inſtrument, and the conſequence was the ſame. I then tried the ſpirit thermometer (D) which became ſtationary at 28°½; and another ſpirit thermometer (E) which I took out of the freezing mixture, where it was at 35°, and it roſe to 30°; and by comparing the ſpirit thermometers with mercurial ones, and alſo with another ſpirit thermometer (H) it appears, that 29° on the former is about equal to 40° on the ſcale of both the latter. By the time theſe obſervations were taken, the frozen lump was looſened in the gallipot: I turned it out, and beat it with an hammer; it yielded a dead ſound and flattened, but its coheſion was very weak; for, inſtead of expanding into a thin plate, as in other inſtances when frozen in the bulb of a thermometer, it crumbled to pieces, and had not that poliſh, which I had before conſtantly obſerved. I attributed theſe circumſtances to the effect of the ſpirit of nitre on the quickſilver. It thawed very ſoon after its parts were disjoined by the ſtroke of the hammer.

Experiment X. made January 26, 1782.

Quickſilver frozen by the natural cold in Hudſon's Bay.

The ſubject of this curious phænomenon was quickſilver put into a common two-ounce phial, and corked. The phial was about a third part full, and had been conſtantly ſtanding by the thermometer for a month paſt. At eight o'clock this morning I obſerved it was frozen rather more than a quarter of an inch thick round the ſides and bottom of the phial, the middle part continuing fluid. As this was a certain method to find the point of congelation, I introduced the mercurial thermometer (F) and the ſpirit thermometer (D) into the fluid part, after breaking off the top of the phial, and they roſe directly and became ſtationary; the former at 40° or 40°½, the latter at 29°¾, both below the cypher. Having taken theſe out, I put in two others, (G) and (E); the former became ſtationary at 40°, the latter at 30°. I then decanted the fluid quickſilver, to examine the internal ſurface of the frozen quickſilver, which proved very uneven, with many radii going acroſs; ſome of theſe reſembled pins with heads. Urgent buſineſs called me away an hour. On my return I found a ſmall portion only had liquified in my abſence. I then broke the phial entirely, and with a hammer repeatedly ſtruck the quickſilver. It beat out flat, yielded a deadiſh ſound, and became fluid in leſs than a minute afterwards. I ſhould have mentioned, that I brought the thermometer (F) into a room, where it roſe to 55° above the cypher, and then let it cool again in the open air, before I put it into the frozen quickſilver. My reaſon was, for fear the quickſilver in the thermometer ſhould be frozen ſo as to render

the obſervation uncertain; but I did not obſerve it differed any thing of conſequence from (G) which was not taken in, but put directly into the phial. By the comparative obſervations of the ſeveral thermometers it appears, that 30° on the ſcale of the ſpirit thermometers (D) and (E) is about equal to 40° or 41° on my ſtandard ſpirit thermometer (H). The following was the ſtate of the inſtruments that morning,

	A.	B.	D.	E.	F.	G.	H.
At eight	− 103	− 80	33½	33	42½	42	46
At nine	− 323	− 444	− 29	− 29½	− 40	− 40	− 44
At noon	34	32	21	21½	30	29½	34

It may be worth remarking, that the quickſilver in the thermometer (B) which had been very near 500°, and was then at 444°, very readily run up and down the tube by elevating either end of the inſtrument.

EXPLANATION OF PLATE VII.

Fig. 1. The thermometer ſeen in front.

A. The ſtem and bulb reaching below the ſcale.

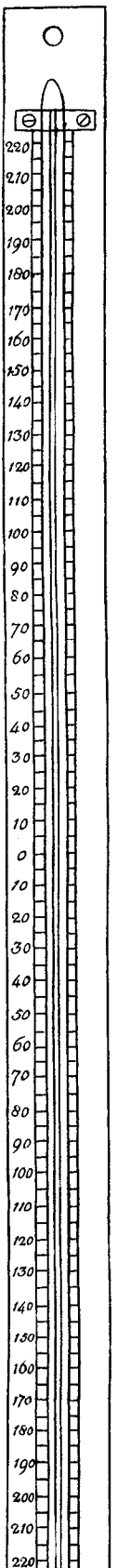
B. B. Worſted wrapped round the ſtem, in order to keep it ſteady in the cylinder, and prevent the acceſs of air.

Fig. 2. The cylinder, ſwelled at bottom, to hold the quick-ſilver to be frozen.

Fig. 3. A ſection of the whole apparatus when put together, ſhewing in what manner the thermometer is inſerted and retained in the cylinder. This ſection is perpendicular to the ſcale of the thermometer.

Fig. 3.

Fig. 1.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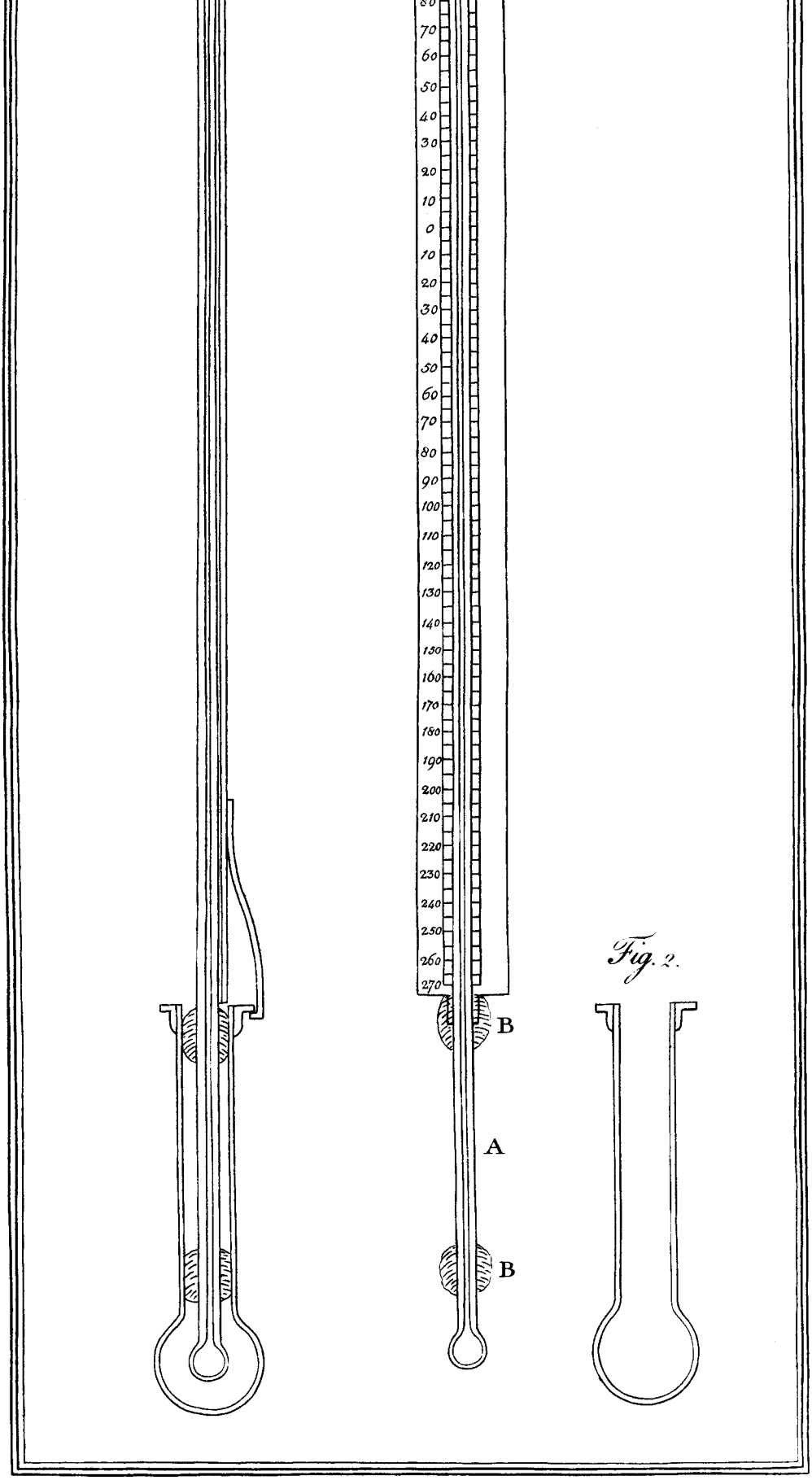
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Fig. 2.